Impulse Super User Training

Jennifer Parker-George

Audiological Scientist, GN Otometrics

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Agenda

- Background
- Optimising your testing
- Customising software
- Interpreting results
- Case studies
- New modules

What is Super User training?

- Increase confidence on how to use your equipment and interpret results more effectively
- Become the “go to” person in your department
- Learn to customise your systems locally
- Explore innovative new vestibular modules

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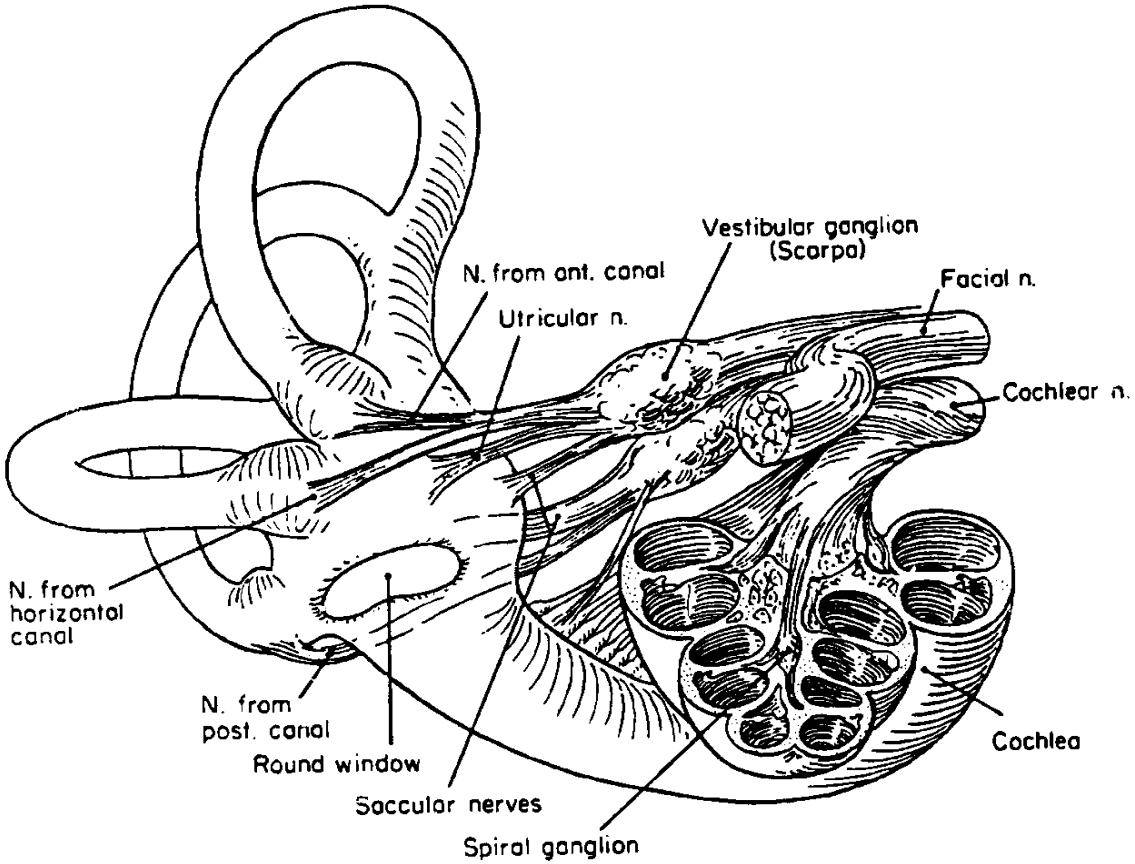
Background and development of the vHIT

Anatomy of the vestibular system

- Three semi-circular canals
  - Lateral
  - Anterior
  - Posterior
- Otolith organs
  - Utricle
  - Saccule



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What happens in our balance systems when we move?

- Deflection of hair cells located in the ampulla of the semi-circular canals and macula of the otolith organs will result in excitatory or inhibitory responses
- Afferent neural information is transmitted along peripheral vestibular nerve to indicate simultaneous excitation and inhibition
- Central processing of information
- Output mechanisms to reflex pathways

Vestibulo-ocular reflex

- Responsible for maintaining stable vision
- VOR produces eye movements which are equal and opposite in velocity and direction to any head movements (Colagiorgio et al., 2013)
- Impaired VOR causes retinal slip, which in turn causes blurred vision and postural instability (Schubert et al., 2004)
- Integrity of vestibular end organs can be assessed through functional measurement of the VOR

Introduction to Head Impulse Test

- First described by Halmagyi and Curthoys in 1988
- Described as bedside test of semi-circular canal function
- Examines the ability to maintain fixation on a target without the generation of abnormal eye movements during an extremely fast angular acceleration of the head

Mechanism of head impulse testing

- Angular acceleration
- Asymmetry between inhibitory and excitatory neural firing patterns
- VOR has two components; one of which, the angular reflex, controlled by semicircular canals will compensate for head rotation (Hain and Helminski 2007)

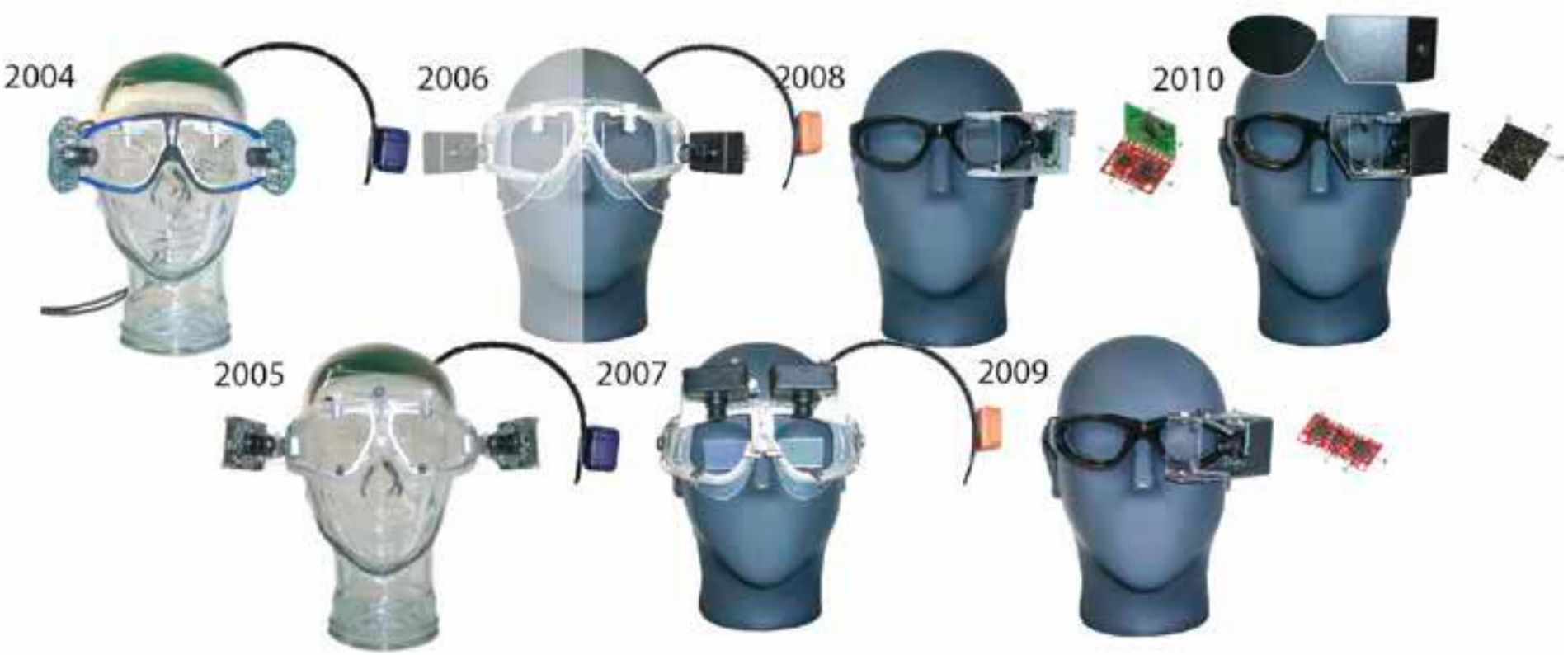
Limitations of bedside technique

- Mean sensitivity of 46% and specificity of 94%
- Very subjective
  - Relies on examiners ability to interpret and detect overt saccades
  - Early results were very variable due to technique and experience
- Difficult to detect covert saccades occurring during head movement (Weber et al 2008)
- No feedback as to how well impulses are delivered or at which frequency

Objective methods

- Gold standard is to use a scleral search coil (Webber et al 2008)
  - Able to demonstrate high specificity and sensitivity
  - Able to detect covert saccades
  - Expensive to use in a clinical setting (Roberts et al., 2008) and can cause patient discomfort (Duchowski, 2007).
- Alternative method proposed to use high speed video cameras and accelerometers

Development of the ICS Impulse goggles



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Accuracy of vHIT

- High sensitivity and specificity
  - Validated against scleral coils, found to show equal degree of specificity (Curthoys et al 2010)
- What makes it so accurate?
  - High speed camera
  - Lightweight goggles
  - Dual axis gyroscopes measure head movement
  - Uses two software algorithms; collection and analysis

Optimising your testing with the Impulse

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vHIT overview

- Simple test
  - But requires practise!!
- Passive, unpredictable, abrupt head turns
  - Angular acceleration to peak head velocity, followed by immediate deceleration
- Each head turn is called an impulse or a trial
- In healthy subject, both eyes should move to compensate

Halmagyi's 'Four Rules' for vHIT testing

1. Minimise slippage
2. Obtain a good eye image
3. Small, abrupt movements
4. Patient must be able to see the target, understand process and cooperate

Patient set up

- Patient cooperation
  - Wide eyes
  - No blinks
  - Fixate
  - Relax neck
  - Avoid patient ‘helping’
- Patient sitting 1 meter from fixation dot on adjustable chair
- Room requirements
  - Lighting

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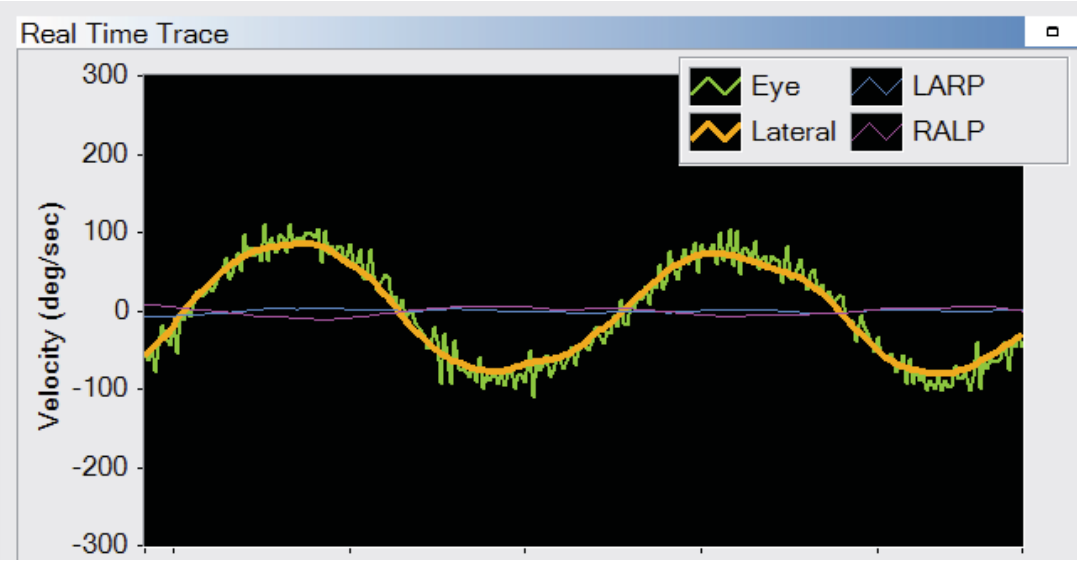
Optimising eye recording

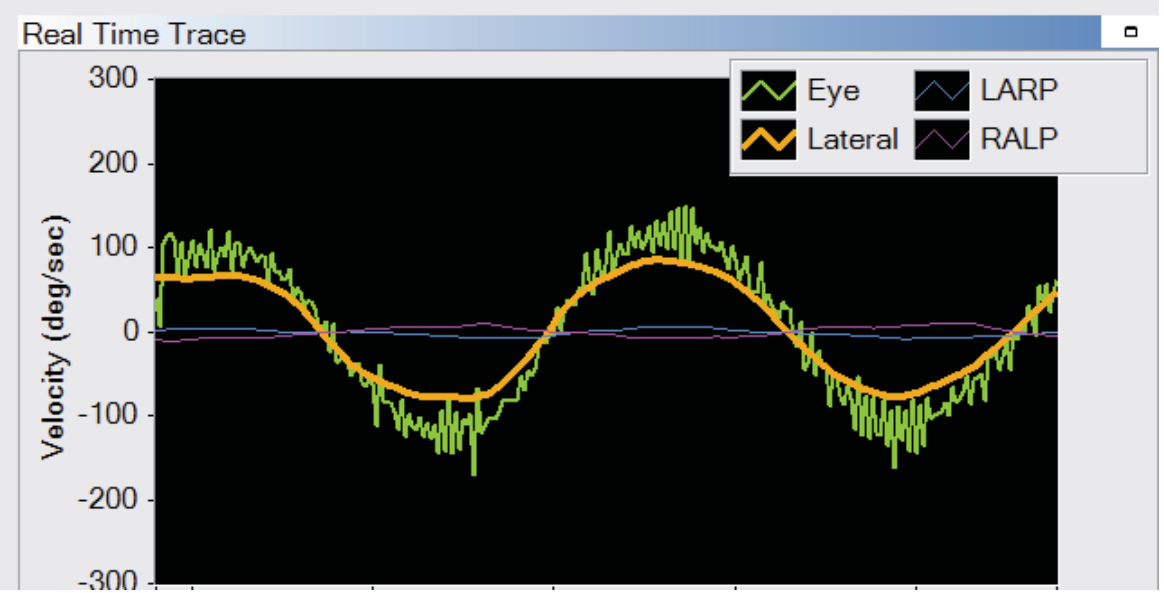
- High frame rate
- Ensure goggles positioned correctly
- Aim for sharp, white round pupil and everywhere else to be black
- Make sure eyelids are not interfering

Calibration check

Good calibration



Poor calibration



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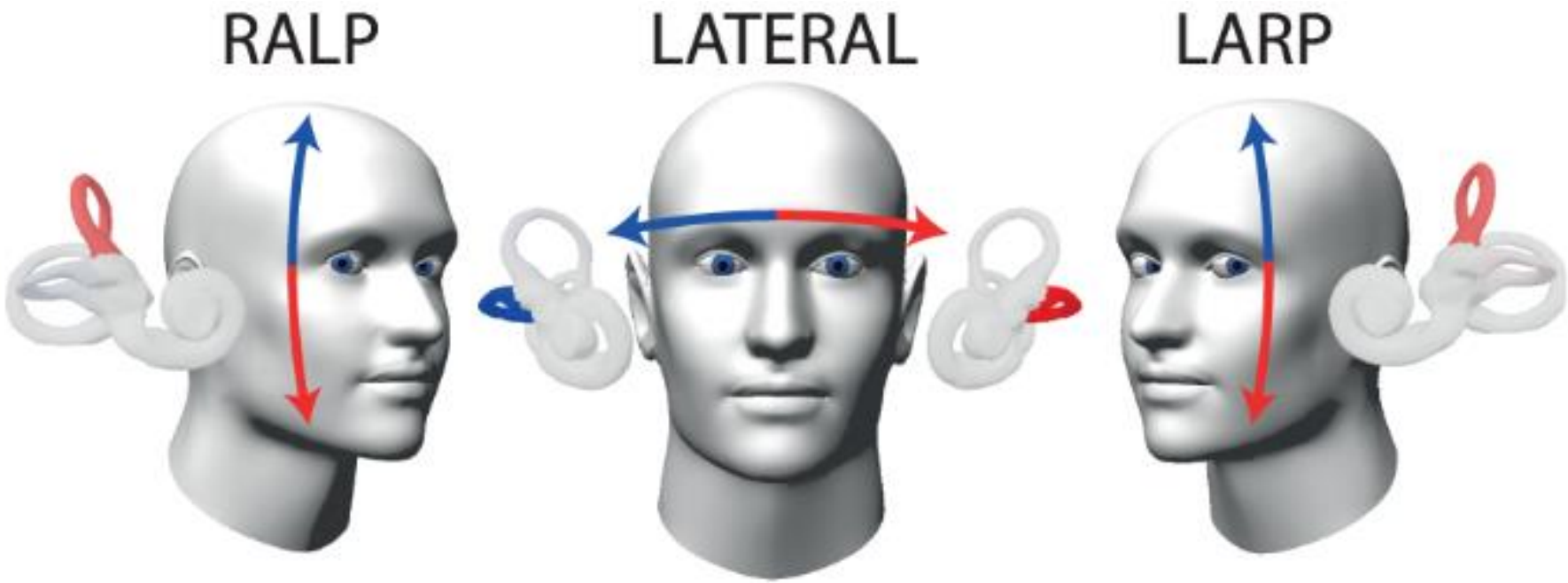
Delivering good head impulses

Assessing all six semicircular canals



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Testing the lateral semi-circular canals

Stimulus

Displacement = 10° to 20°

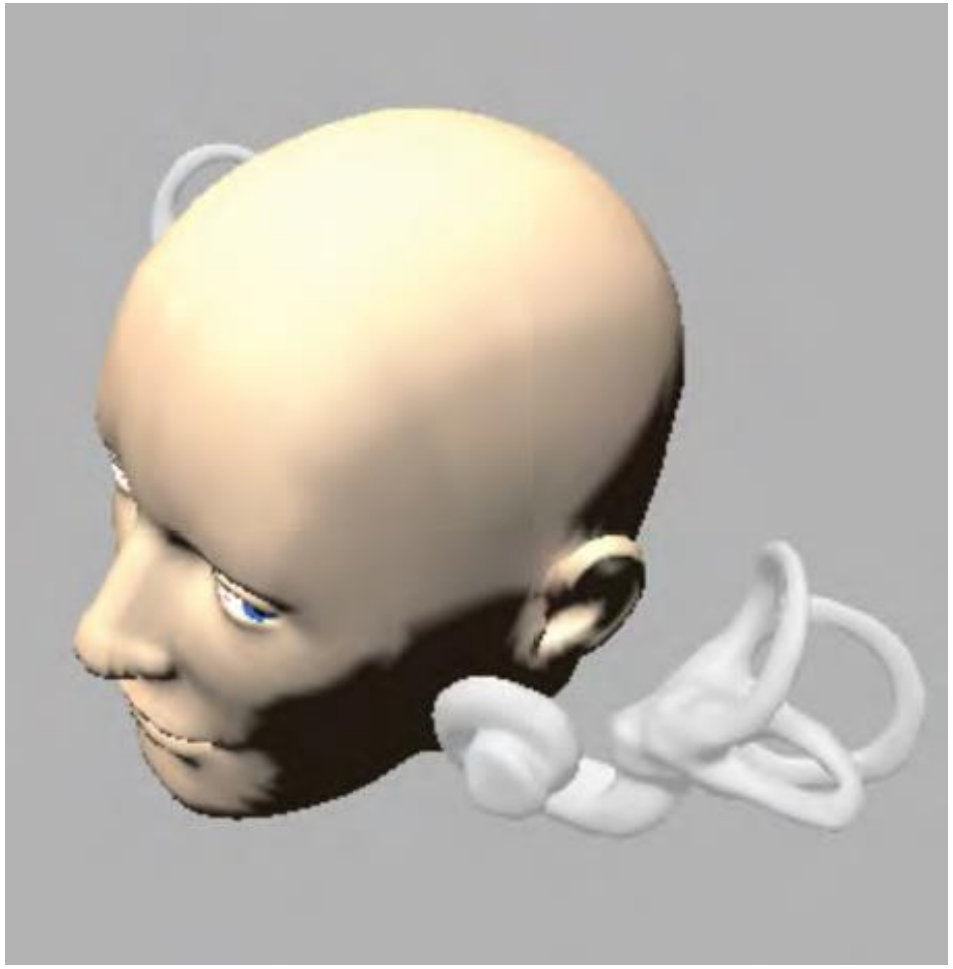
Peak Head Velocity = 100°/s to 250°/s

Peak Head Acceleration = 1000°/s^2 to 2500°/s^2

Taken from Curthoys et al.

Testing the anterior and posterior semi-circular canals

- Turn head 35/45° and patient looks back at fixation point
  - Ensures purely pitch motion
  - Stimulates correct canals
- Small, unpredicatable head movements
  - 10-15° amplitude
  - 100-150 ° velocity
- Movement:
  - Downward stimulates anterior canal
  - Backwards stimulates posterior canal



How many impulses?

- Each impulse is a separate measure of vestibular function
- Repetition valuable for providing increase confidence
- 20-30 recommended
  - May not be necessary or appropriate
- Quality, not quantity

Common pitfalls

- Goggle slippage
- Predictable head movements
- Sitting patient too close to target

Operator raining

- Practise to ensure good delivery and good velocity ranges
- Examples of ways to practise…
  - Melon
  - Head torch/laser

vHIT Practical

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Customising your Otosuite V software

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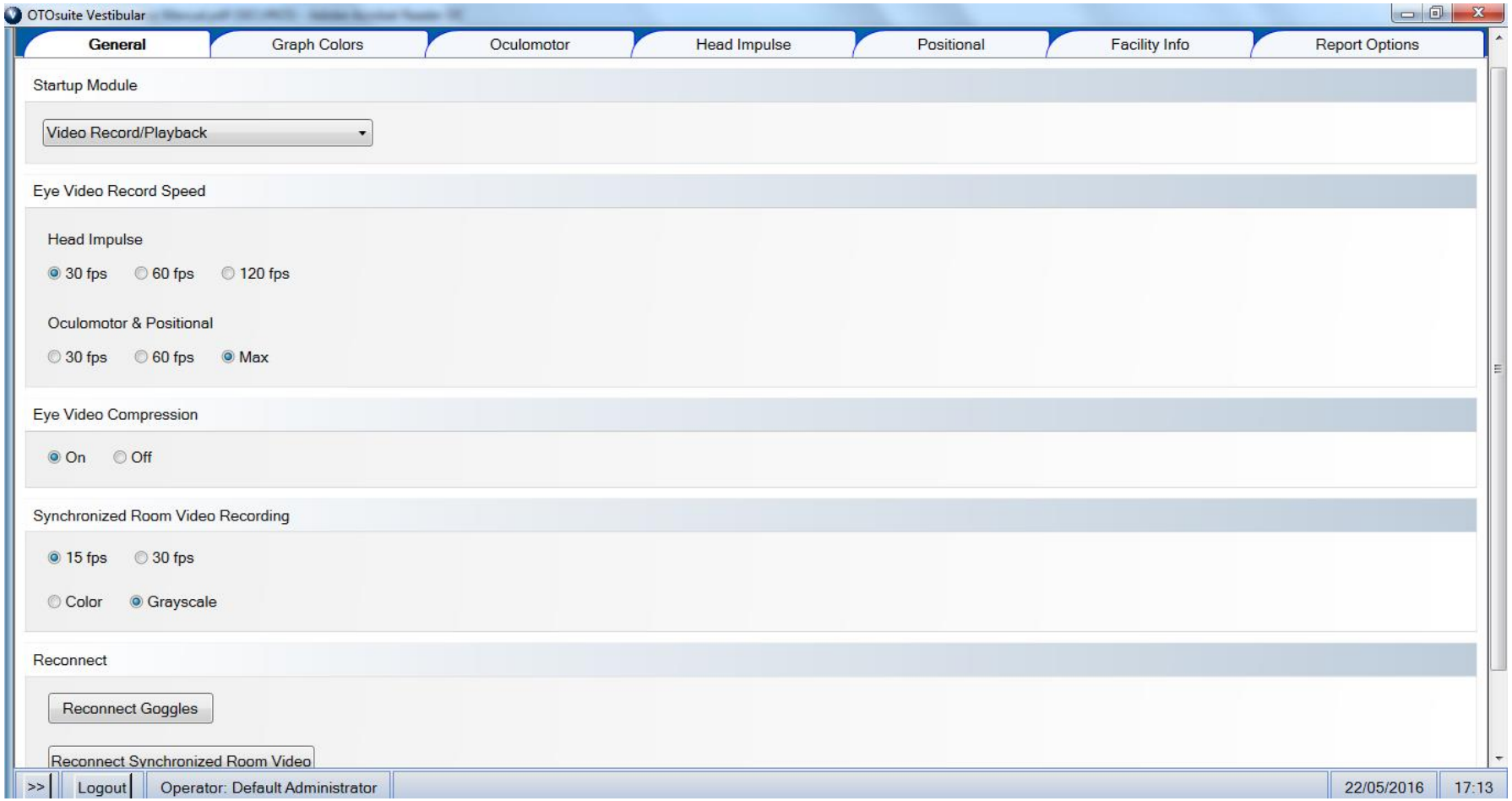
General set up



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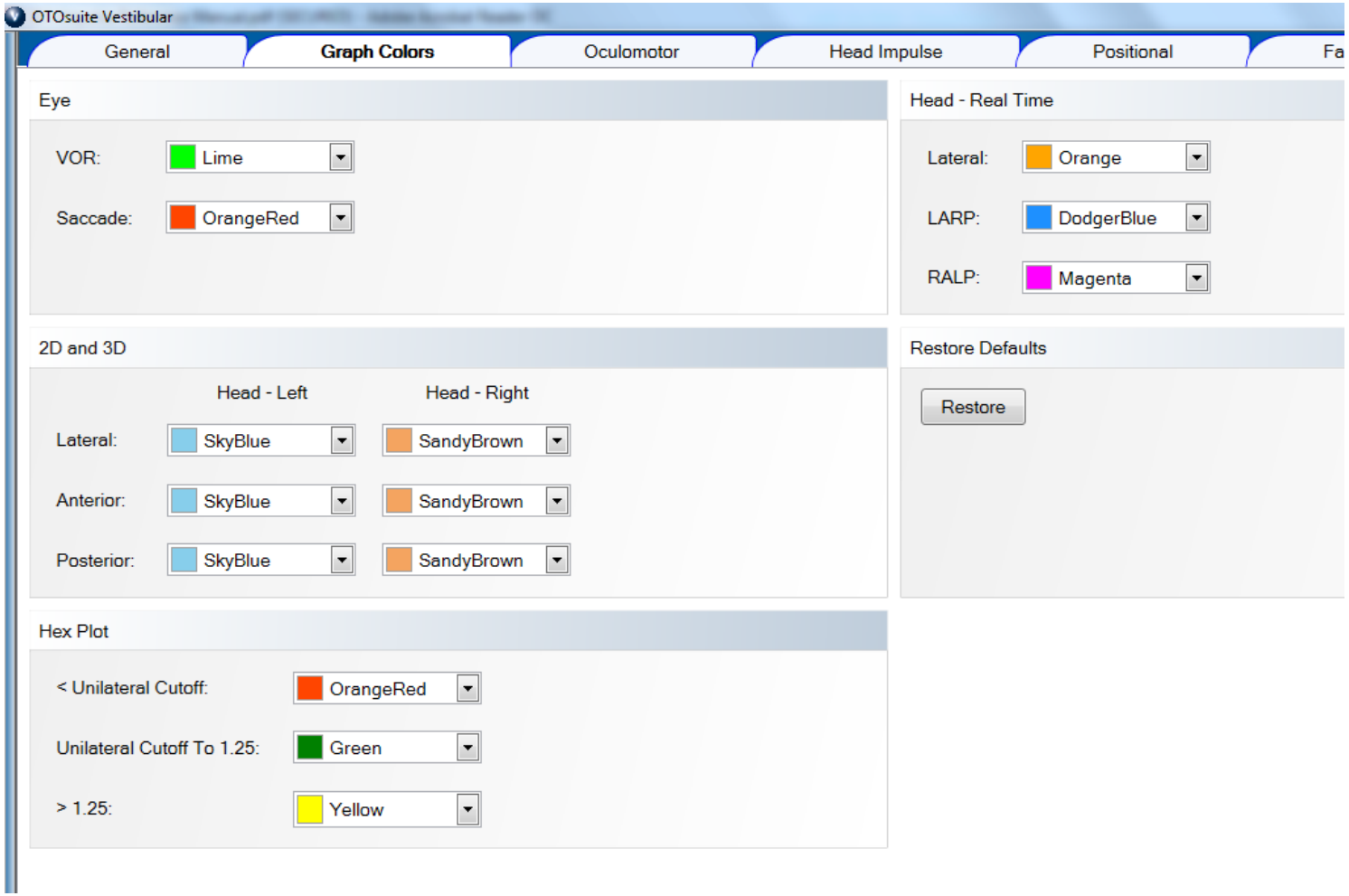
Graph colours



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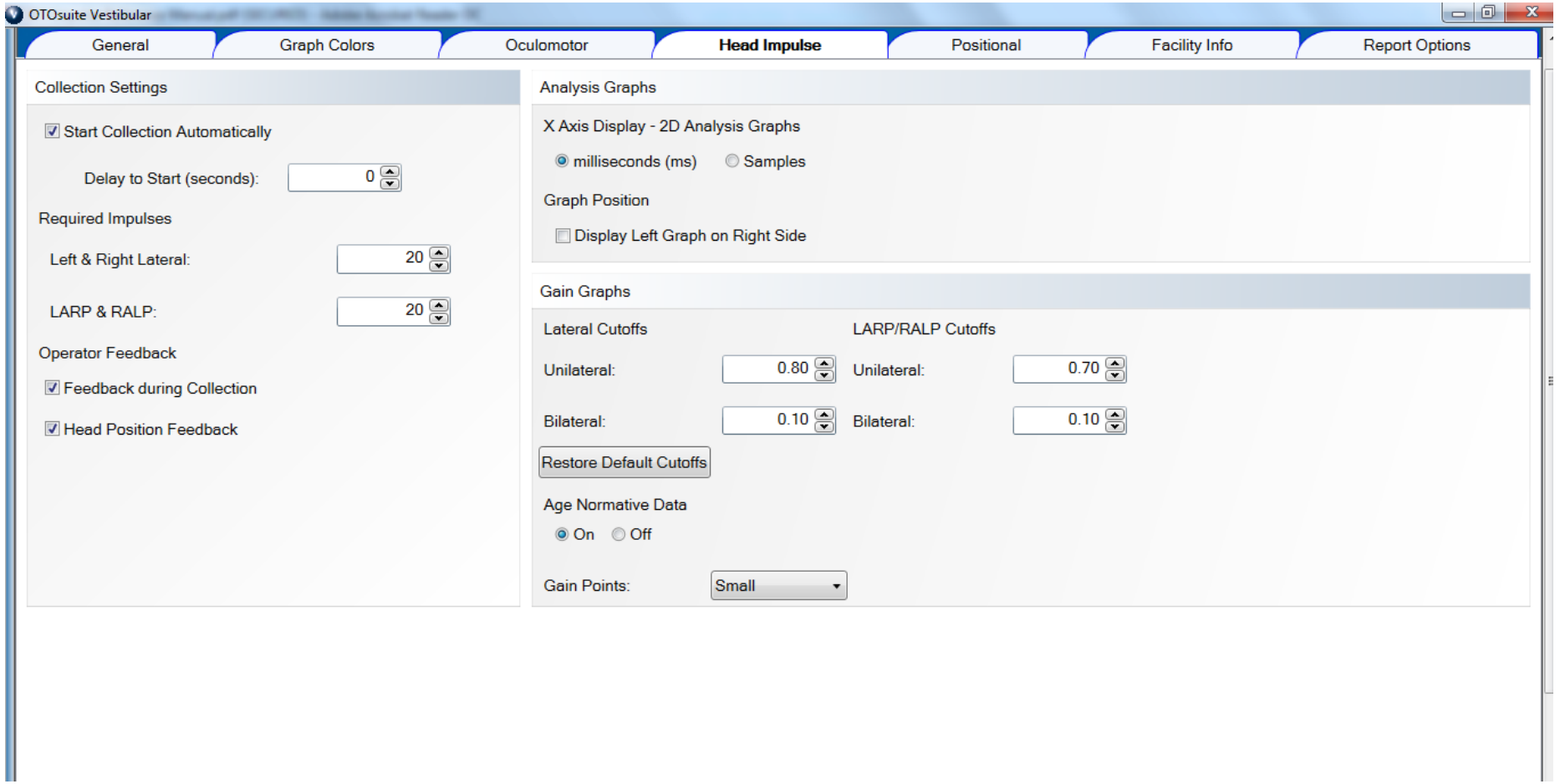
Head impulse options



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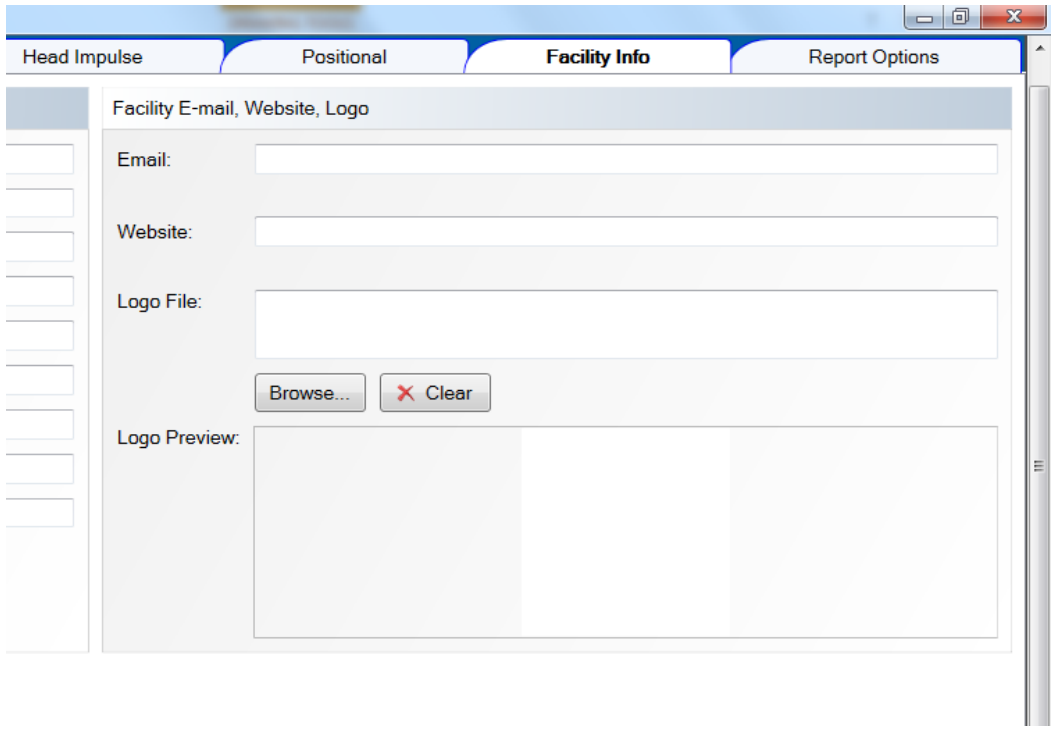
Adding a logo to your reports



- Browse
- Navigate to locations of the file being used for the logo
- Select the file
- Click open
- To remove the logo, click clear

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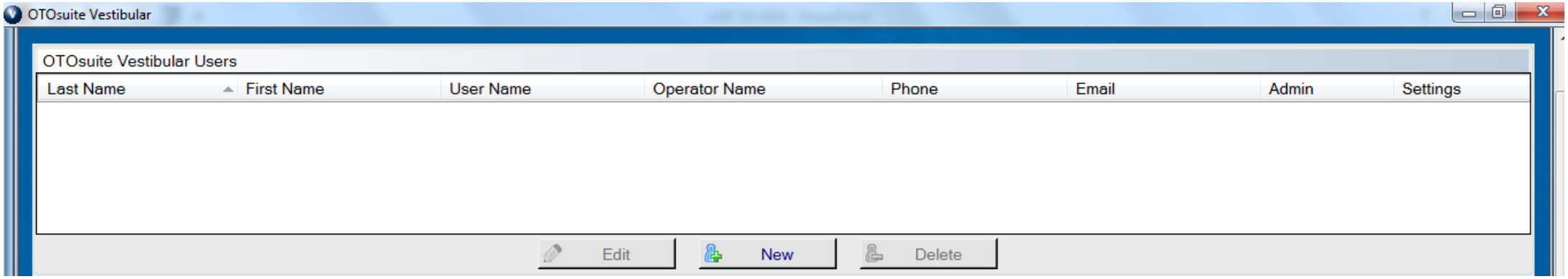
Setting up new users



1. Admin= all rights
2. User = all rights except…

- Add, edit or delete users
- Specify network locations for shared files
- Update licenses or firmware

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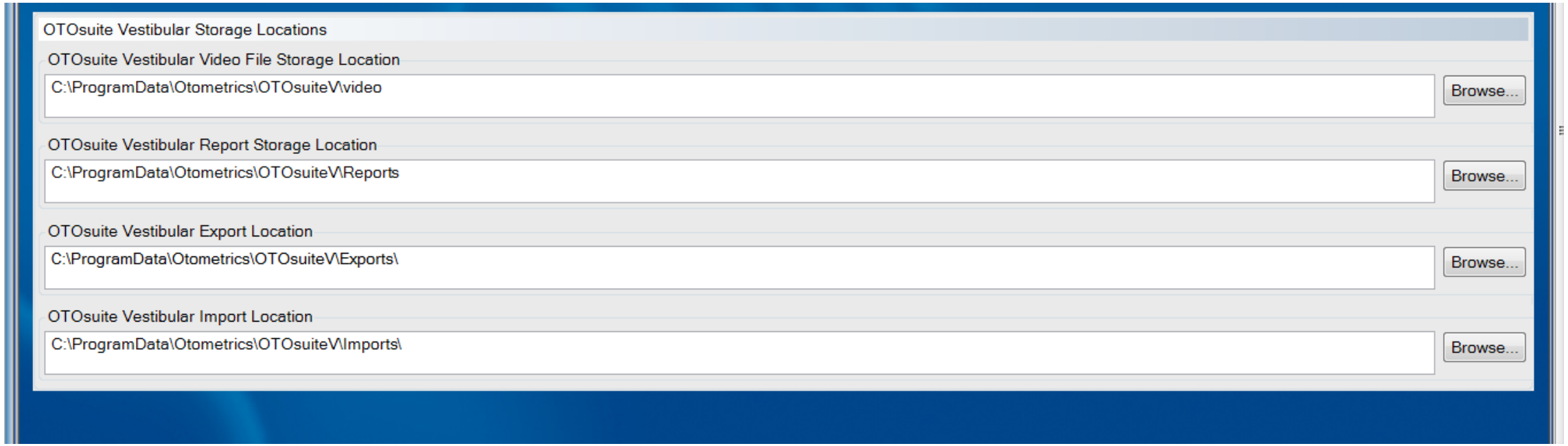
Changing storage locations



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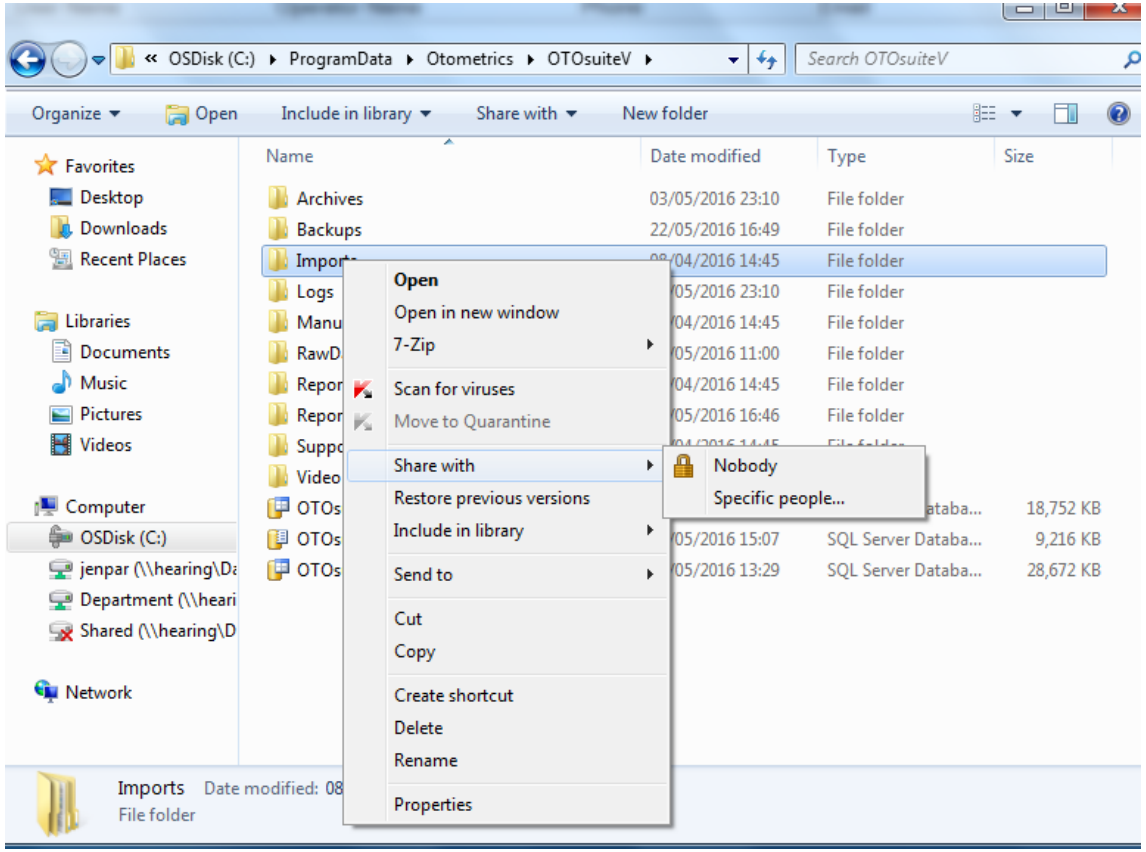
Set sharing properties for new storage locations



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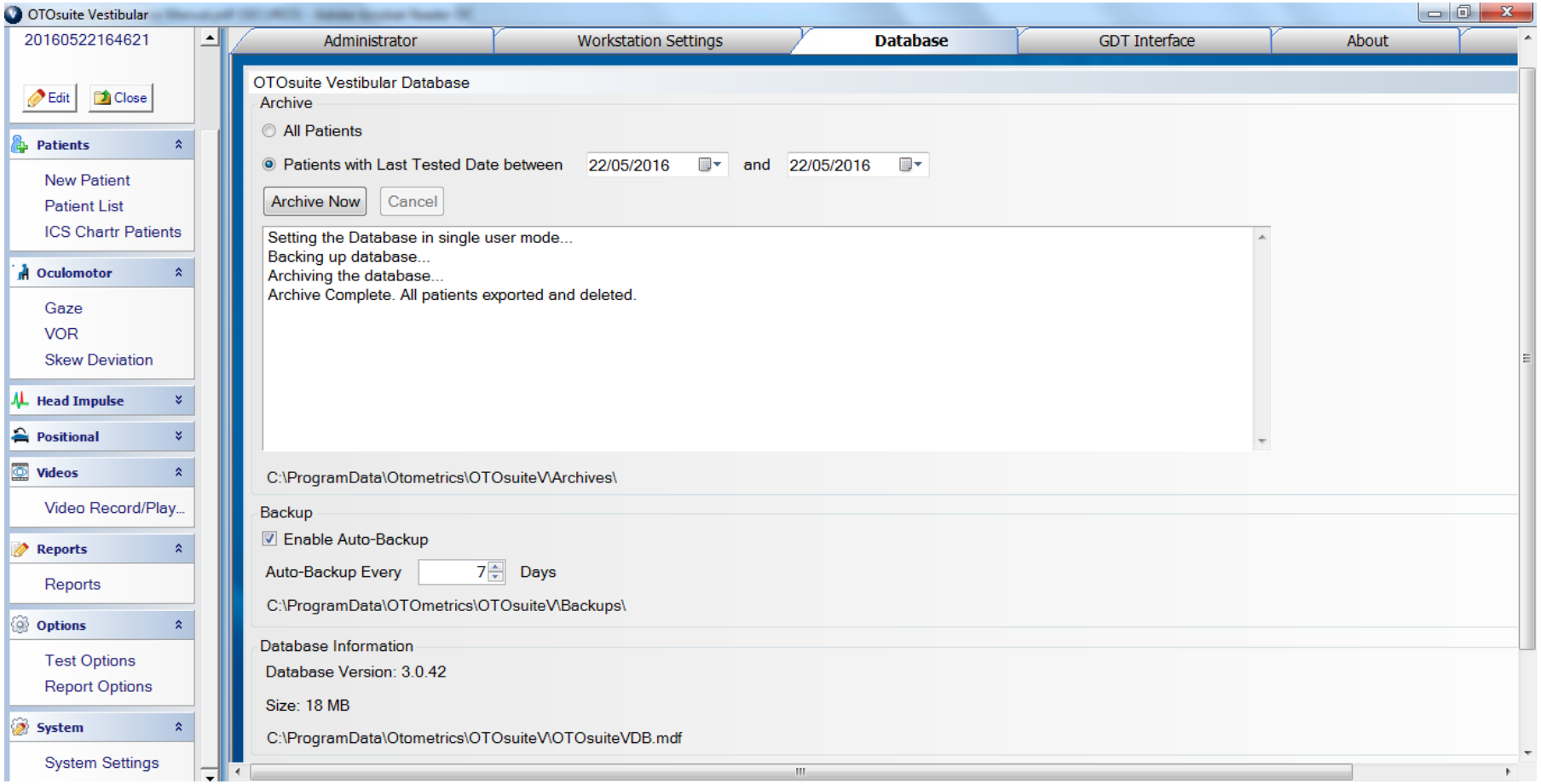
Archiving and backup



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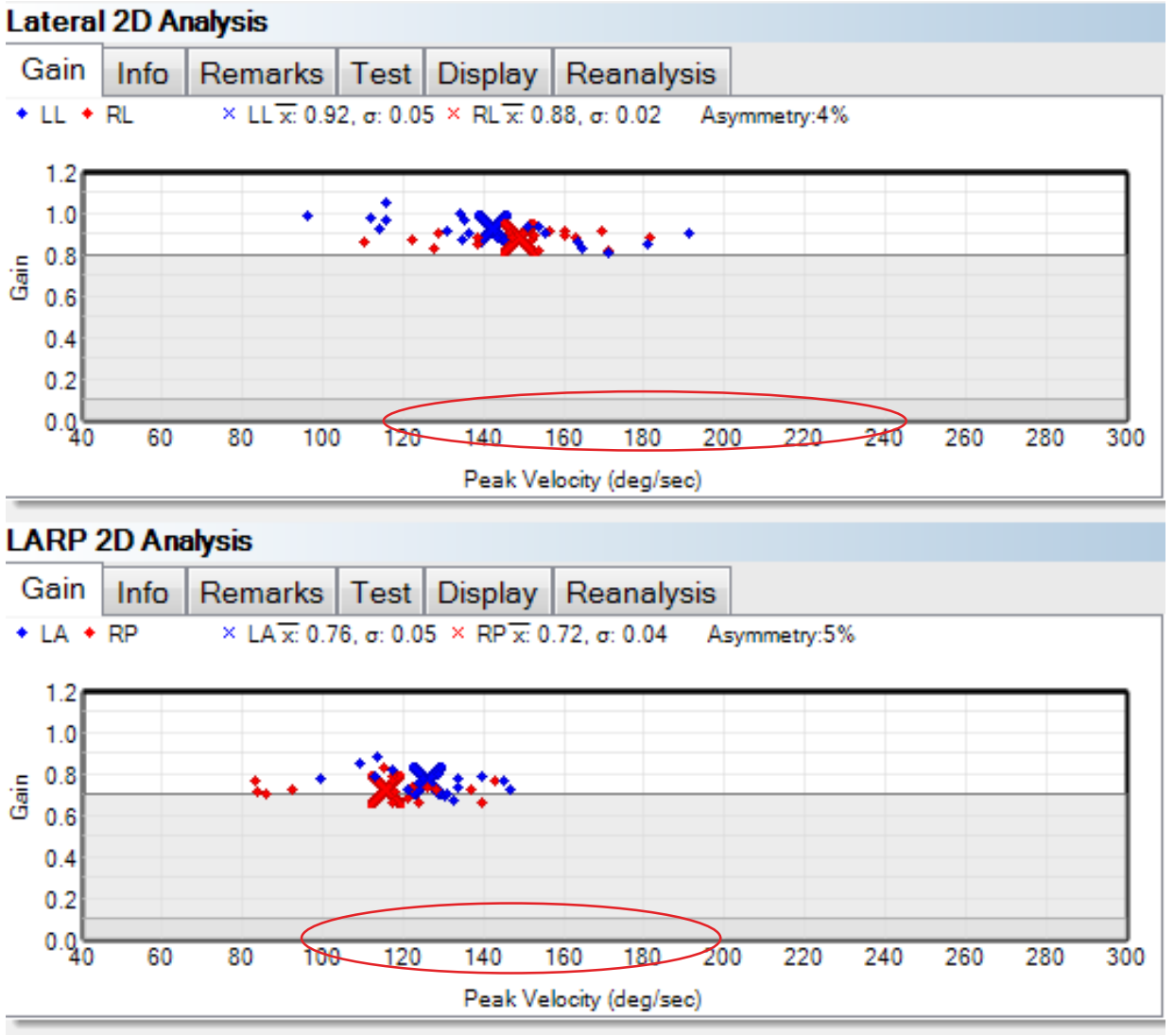
Results interpretation

Reviewing data

- Crucial to ensure results are acceptable
  - Clustered results
  - Check velocity range



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Are your velocities high enough?

"Many patients with unilateral vestibular loss may show normal VOR gain for ipsilesional head turns at low head velocities (50 deg/s) and their vestibular loss only becomes apparent at higher head velocities (above 150 deg/s).

For this reason it is absolutely essential that in the test there be trials where the head velocity is greater than 150 deg/s.

Operators should not be satisfied with any test result where this velocity is not achieved…. in that case the results are not an adequate test of semicircular canal function and can be positively misleading – suggesting a patient is normal when they have a unilateral deficit, undetected because the vestibular test is inadequate"

Per Jacobson textbook chapter: Ian Curthoys et al. The Video Head Impulse Test

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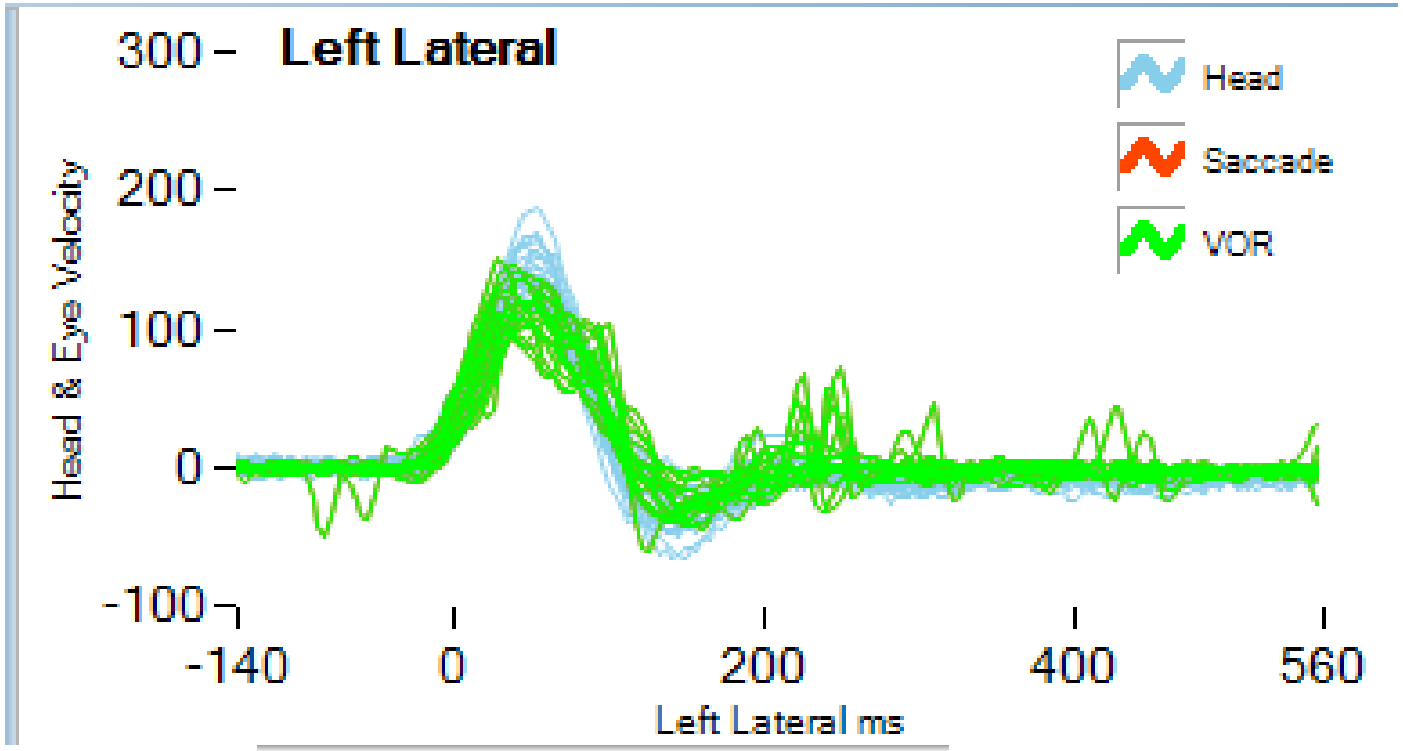
Time series data



- Superimposed records in time series
- Check;
  - Repeatability of stimulus and response
  - Noisy?
  - Overshoot or rebound?

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What should we be analysing?

- Not just saccades or gain
- These are COMPLIMENTARY indicators of vestibular loss

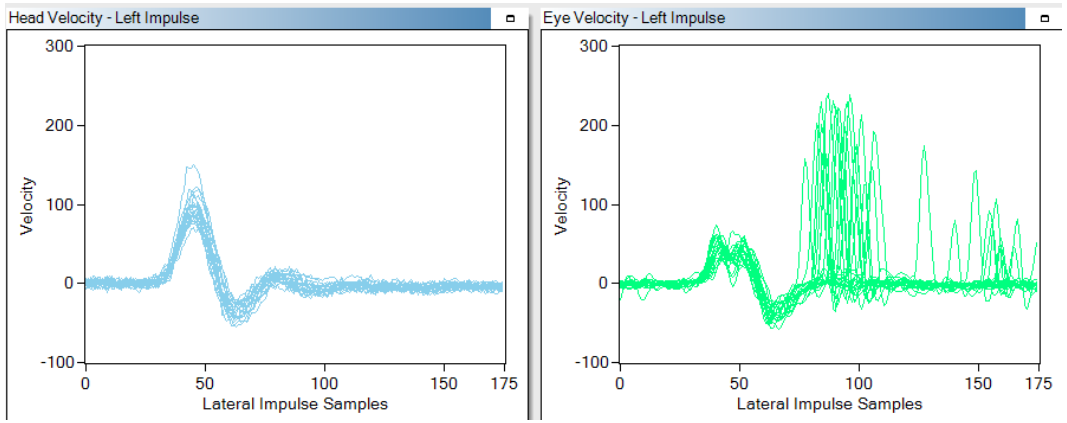
What are saccades?

- Saccades occur when the eyes are unable to maintain fixation on a target during head movement
- Neural signal from semicircular canal does not drive eyes at sufficient velocity
- Quick ‘catch up’ movements

Difference between Overt and Covert

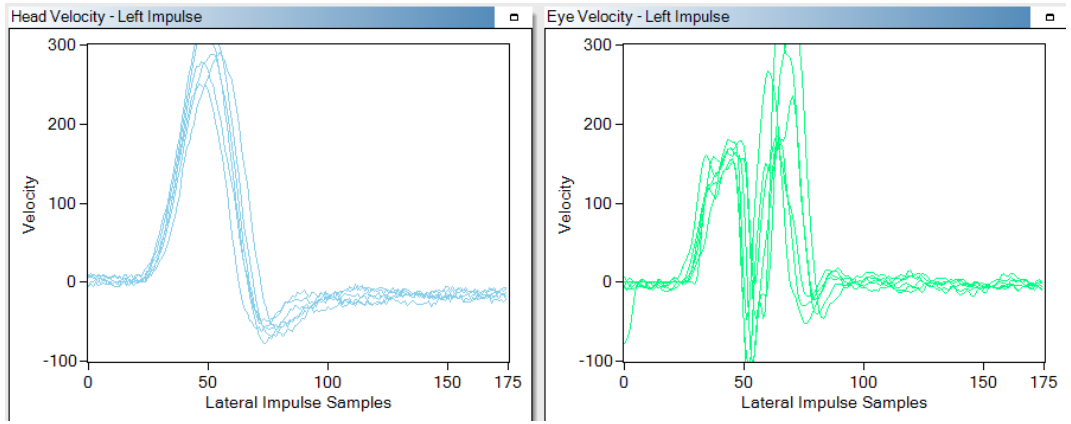
Overt Saccades

- Saccades occur following head movement



Covert Saccades

- Saccades occur during head movement



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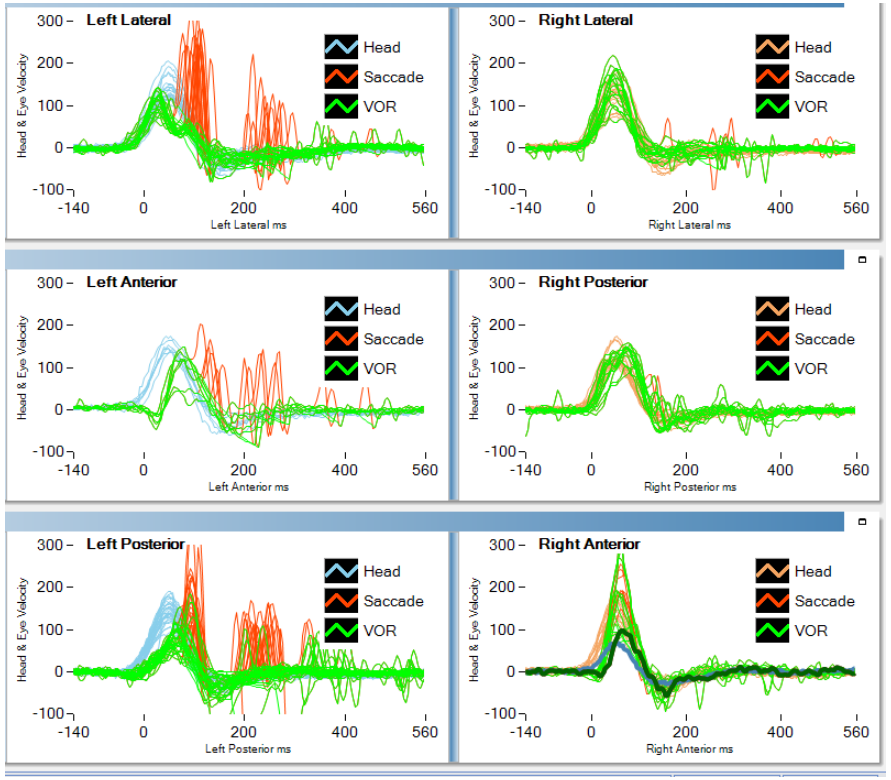
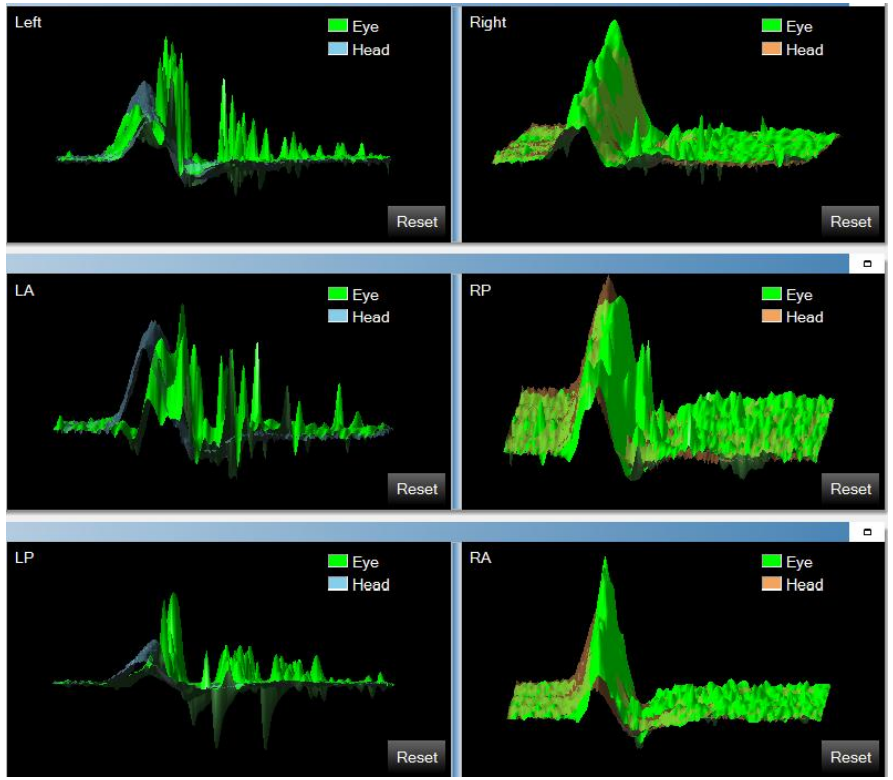
Analysis: Saccades

- Presence or absence of saccades: direction/type/latency/size/consistency





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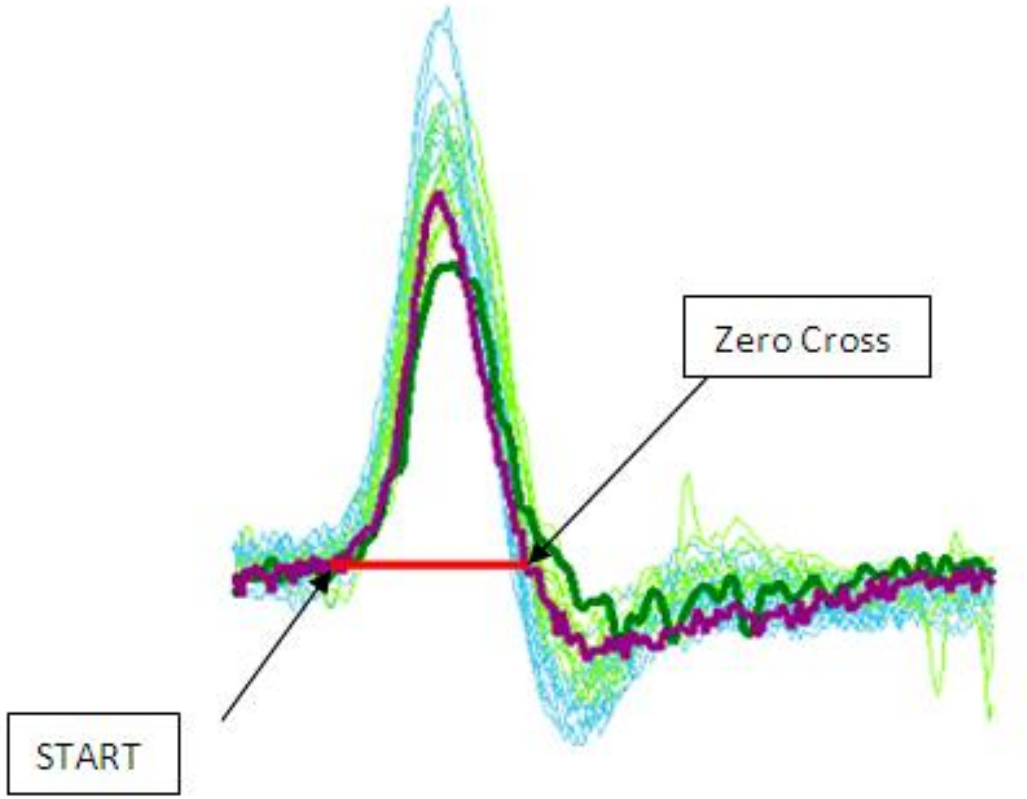
How is gain calculated?



- Gain calculation is based on area under the (de-saccaded) eye velocity vs area under the head velocity
- **Gain = eye-sum divided by the head-sum**
- Note that for the sake of this calculation, the eye tracing is first de-saccaded

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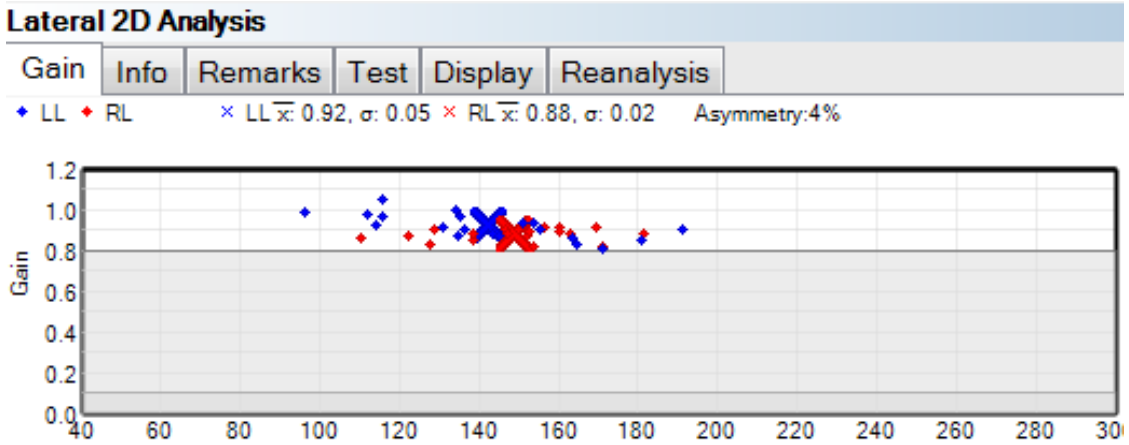
Analysis: Gain

White= normal

Grey= abnormal

Dark grey= bilateral



Mean gain values

	Lateral	Vertical
Normal	>0.8 - <1.2	>0.7 - <1.2
Abnormal: typical results for unilateral loss	0.1- 0.8	0.1- 0.7
Abnormal: bilateral loss	<0.1	<0.1

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Age normative data

- Data collected by McGarvie, MacDougall, Halmagyi, Chiarovano, de Waele, Burgess and Curthoys
- Lateral VOR gain does not decrease with age in healthy adults
- Posterior gain reduces with age
  - Small, but significant

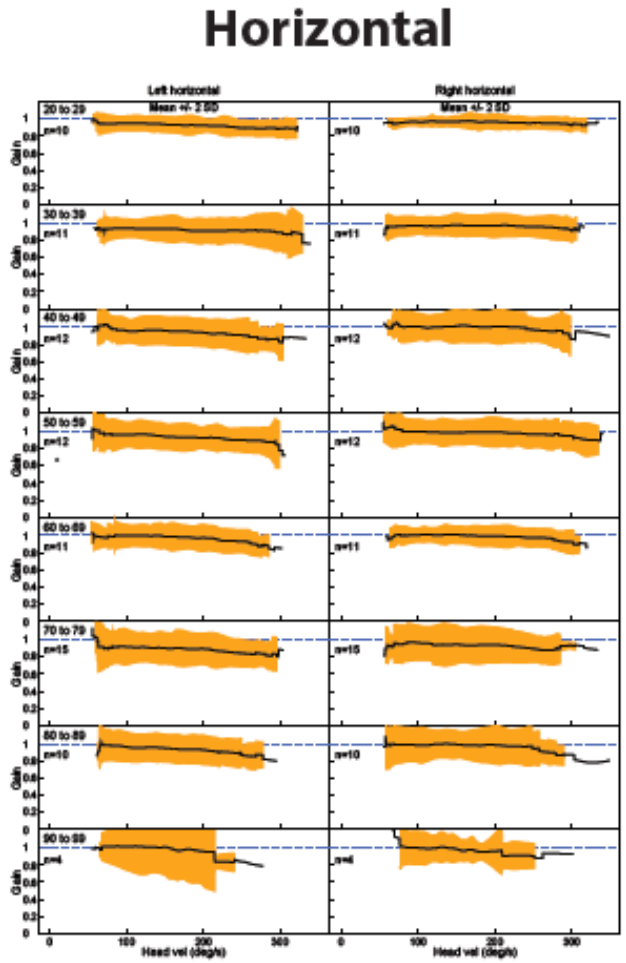

Image taken from Leigh A. McGarvie, Marta Martínez López, Ann M. Burgess, Hamish G. MacDougall & Ian S. Curthoys Horizontal eye position affects measured vertical VOR gain on the video Head Impulse Test Frontiers in Neurology http://journal.frontiersin.org/article/ISSN: 1664-2295

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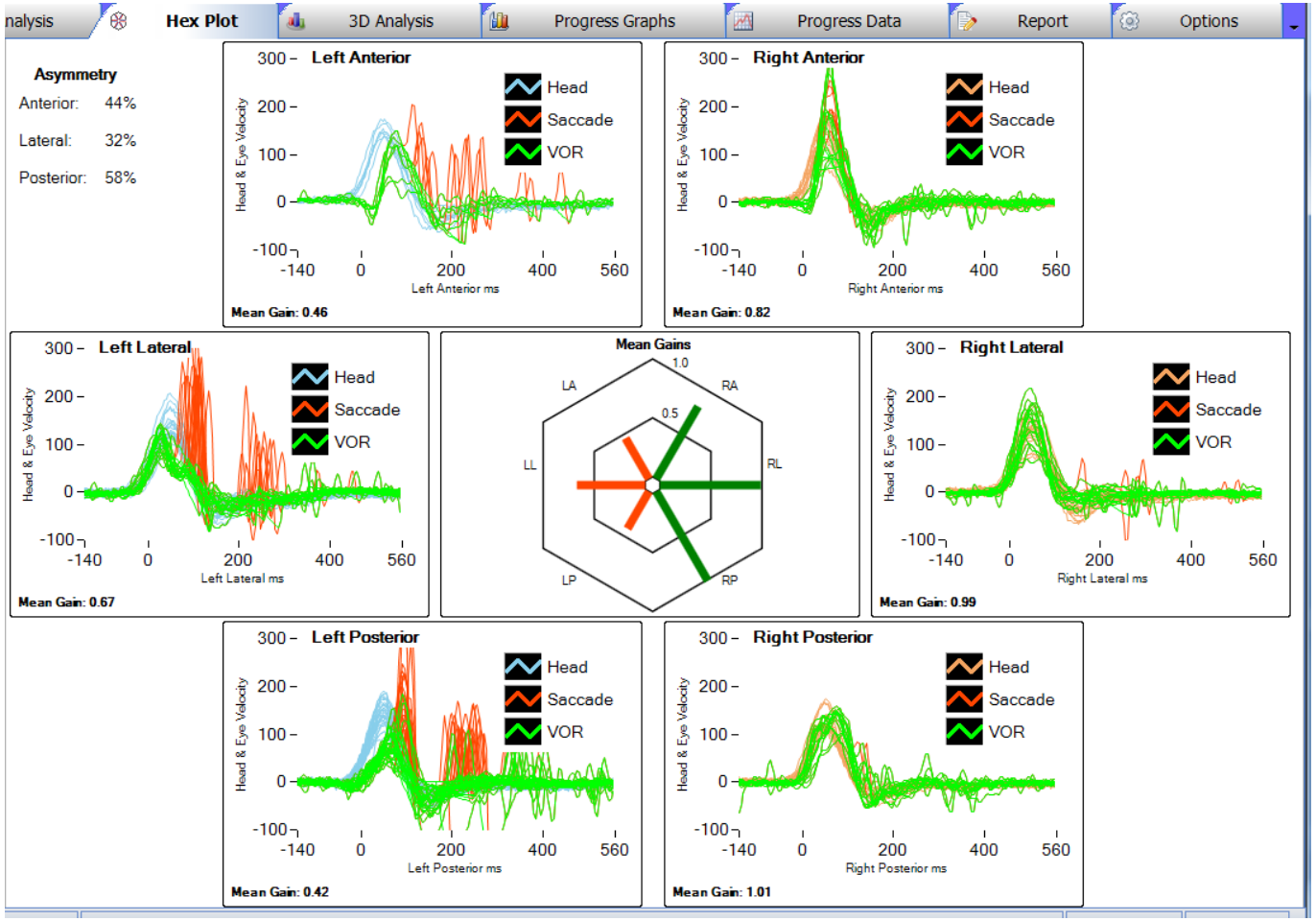
Analysis: Hex plot



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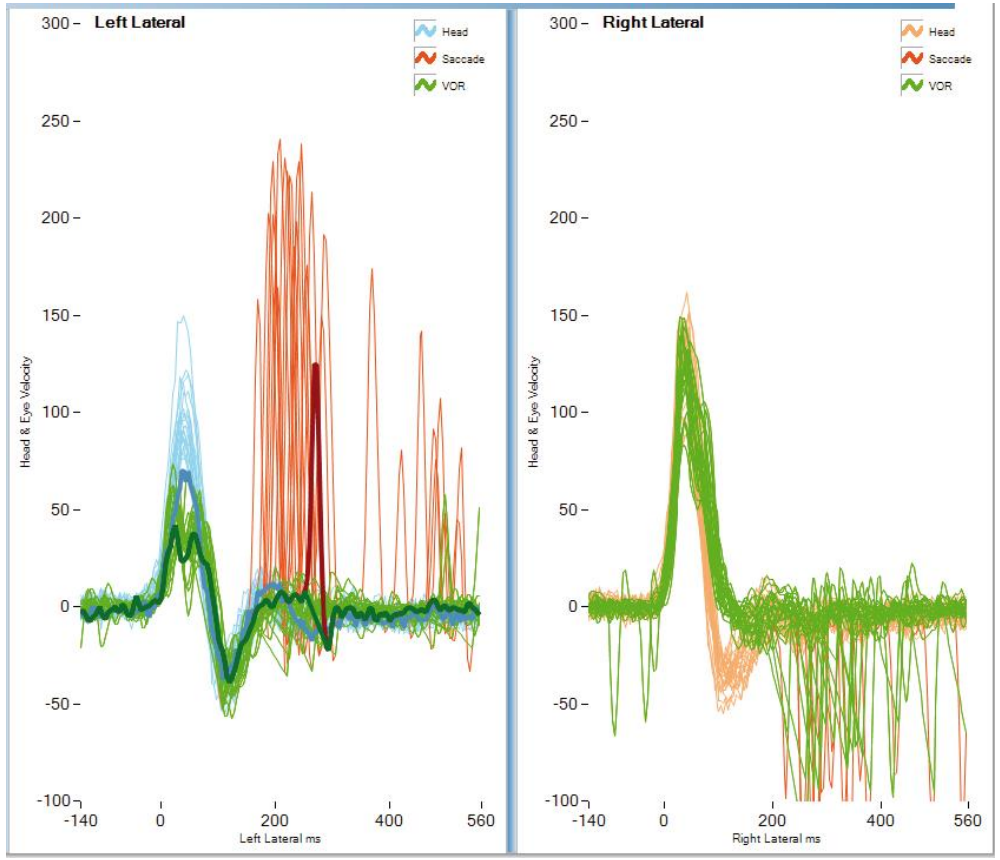
Interpretation troubleshooting

Spontaneous Nystagmus



- Upwards in one direction, and downward in other direction
- Can adjust analysis algorithm if spontaneous nystagmus present
- Be aware that overshoot can also cause saccades in the opposite direction and looks like spontaneous nystagmus

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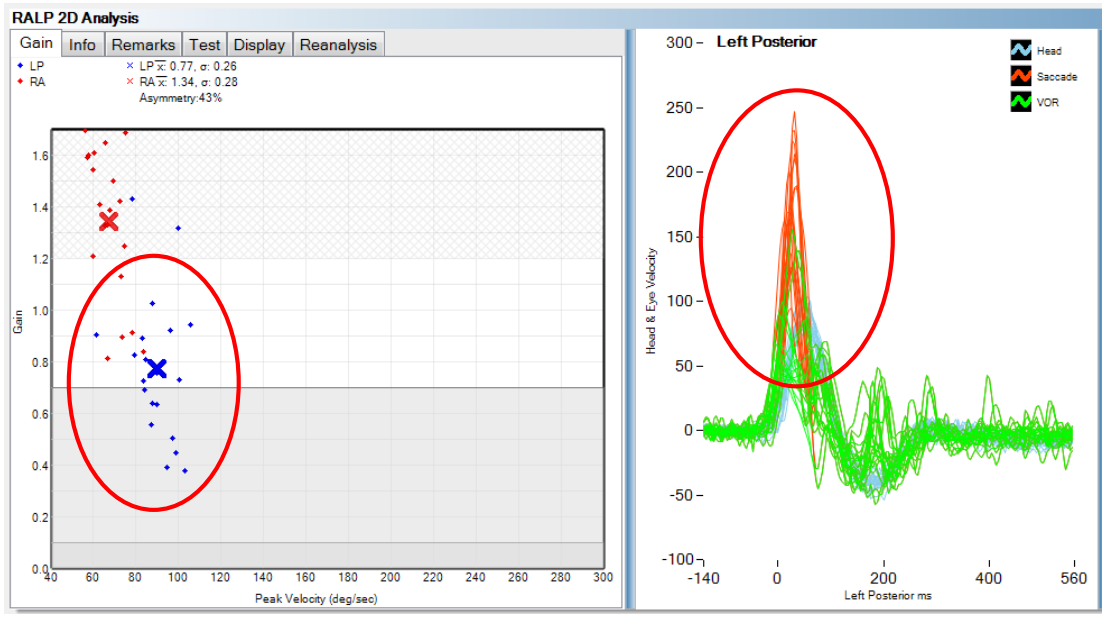
Eye leading the head



- If the eye is leading the head, it is most likely due to improper goggle fit...
  - Use a new face cushion
  - Tighten the goggle strap
  - Clip the cable to the patient's right shoulder
  - Do not touch the strap or goggles during testing
  - Fixation dot must be 1 meter or greater from the fixation target

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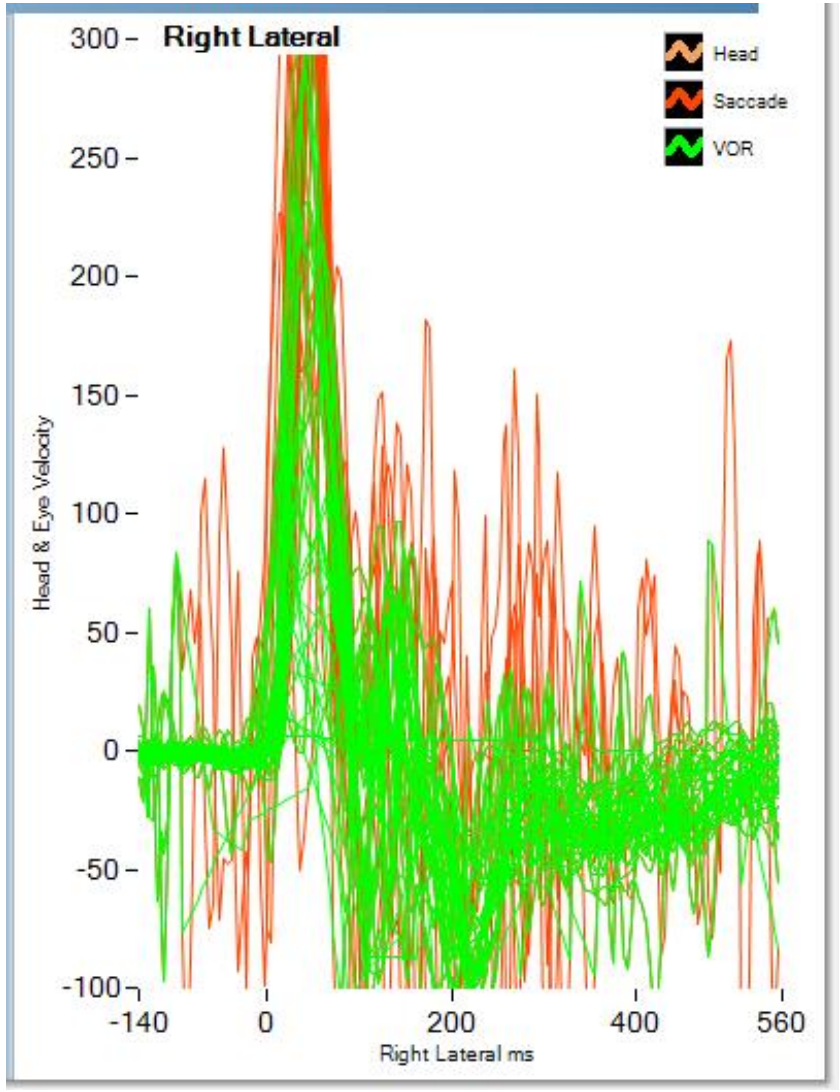
Noisy traces

- Noisy traces
- Caused by
  - Poor pupil detection
  - Patient not looking at fixation point
  - Excessive blinking
  - Mirror not clean



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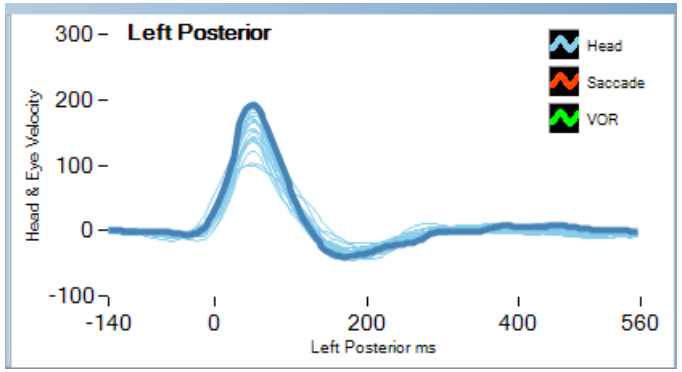
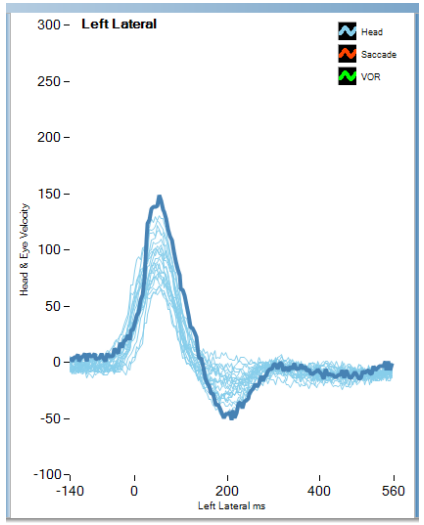
Too much overshoot

- Overshoot is when you do a head impulse in one direction and then quickly bring the head back in the opposite direction
- Operator feedback during testing
- Overshoot obvious on head graphs





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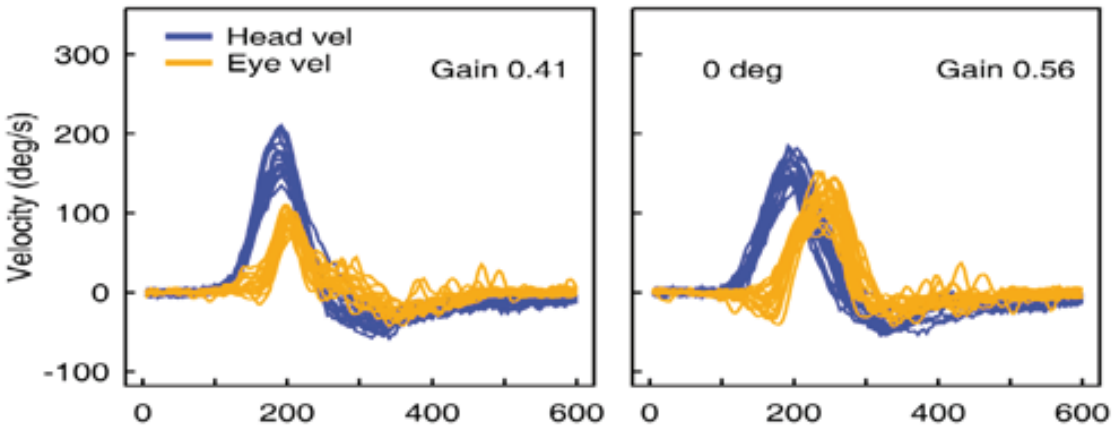
Wrong planes stimulated



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- If the eye trace is shifted to the right of the head trace, the head impulse was directed toward the nose.
  - This is the wrong approach, as it stimulates both sides simultaneously

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New Modules

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CREATE THE SOLUTION THAT WORKS BEST FOR YOU

ICS Impulse® is a customizable solution. Choose between Video Frenzel, Video Head Impulse with age based normative data, Positional and Oculomotor – or choose all four. You decide how ICS Impulse works best for your facility.

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Customisable assessment options

- Monocular video frenzel
- Video head impulse
- Oculomotor
- Positional testing and treatment

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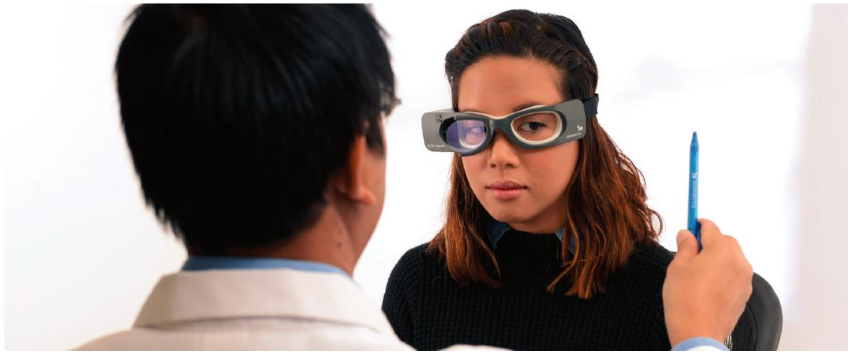
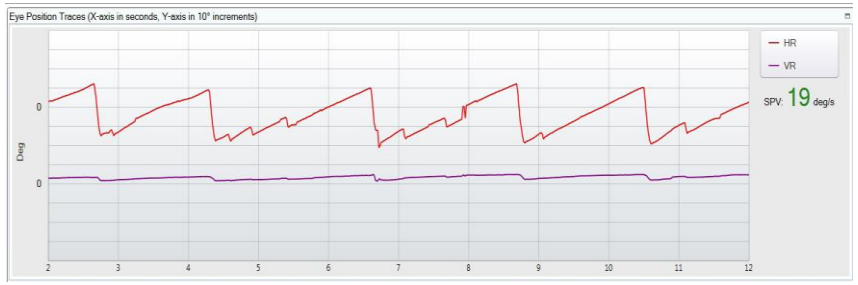
Monocular video frenzel

Oculomotor testing

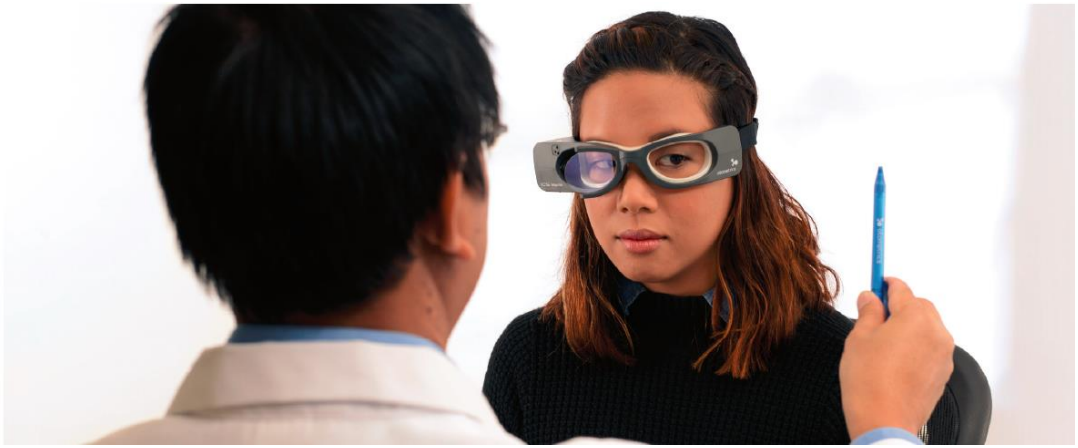
- Assess presence and degree of any **gaze evoked nystagmus** or **spontaneous nystagmus**
- **Visual VOR** and **VOR Suppression**- simultaneously test for the coexistence of vestibular and cerebellar pathology
- **Skew Deviation** - identify if ocular misalignment occurs and diagnose central disorder





Central, Peripheral or Both?

Combining vHIT and Oculomotor assists in answering this question



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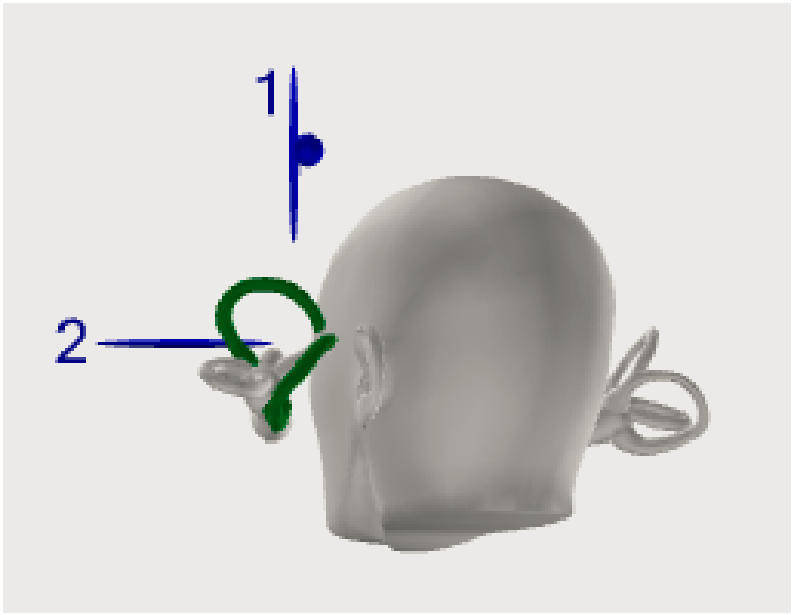
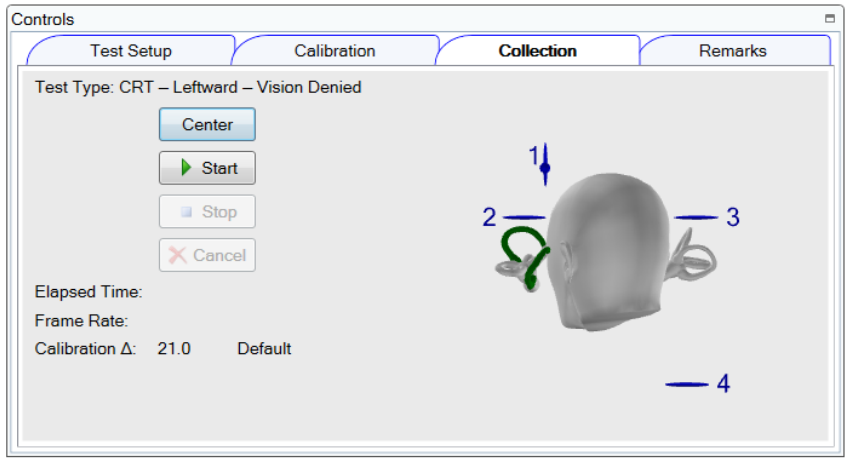
BPPV assessment and treatment

- More accurately assess and treat the most prevalence balance disorder
- Head position feedback ensures appropriate positioning
- Eye position trace and video recording for analysis





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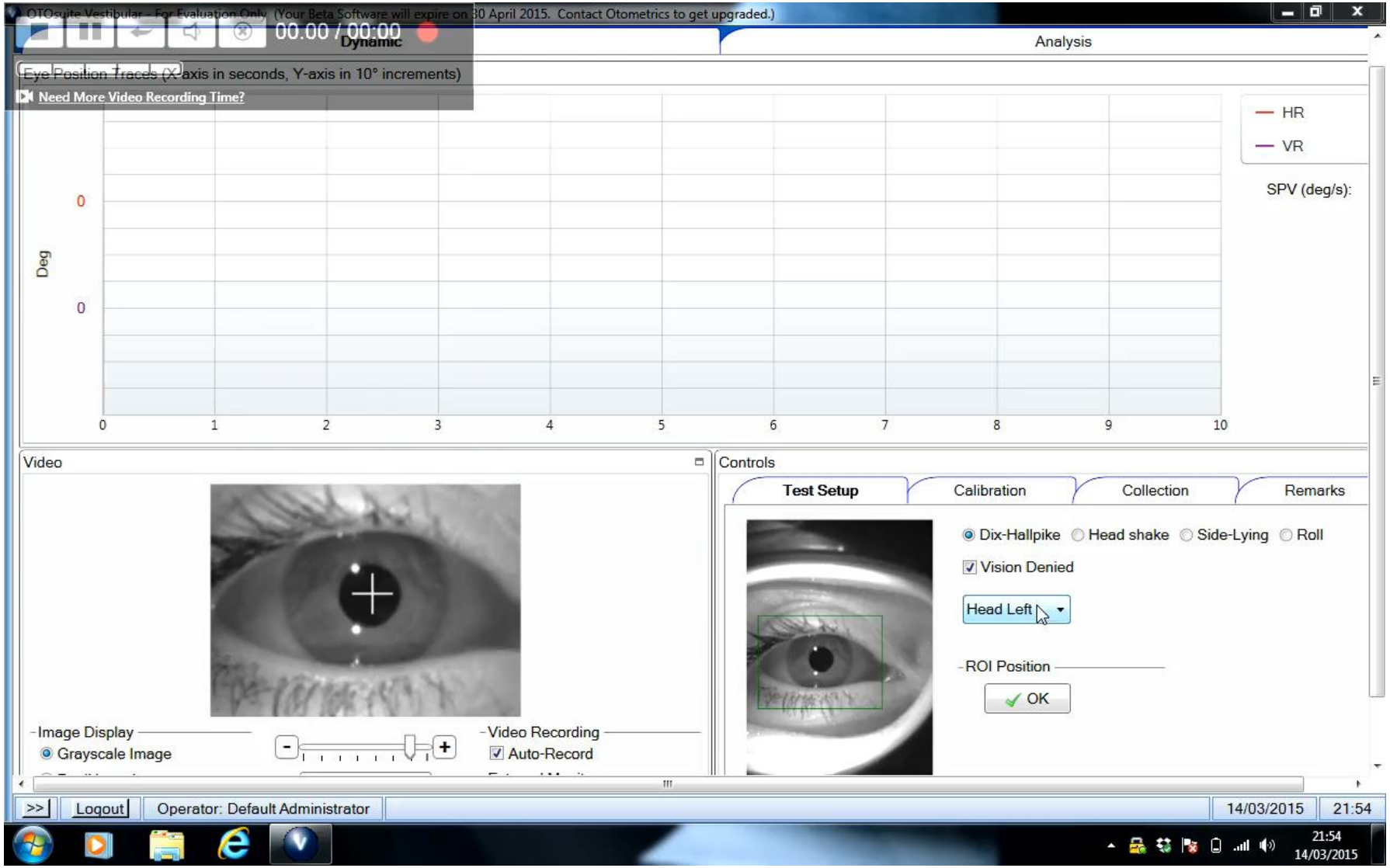
OTOsuite Vestibular - For Evaluation Only (Your Beta Software will expire on 30 April 2015. Contact Otometrics to get upgraded.)
00.00 / 00:00
Dynamic
Analysis
Eye Position Traces (X-axis in seconds, Y-axis in 10° increments)
Need More Video Recording Time?
HR
VR
SPV (deg/s):
Deg
0
0
0 1 2 3 4 5 6 7 8 9 10
Video
Controls
Test Setup
Calibration
Collection
Remarks
Dix-Hallpike
Head shake
Side-Lying
Roll
Vision Denied
Head Left
ROI Position
OK
Image Display
Grayscale Image
Video Recording
Auto-Record
>>
Logout
Operator: Default Administrator
14/03/2015
21:54
21:54
14/03/2015

New modules: Clinical advantages

- Faster diagnosis and quicker treatment of peripheral and central vestibular disorders
- Objective information to guide onward referrals
- Accurate detection and treatment of BPPV
- Less follow ups required
- Seamless and efficient patient journey = more satisfied patients

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vHIT Practical

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Clinical use

Diangostic Utility

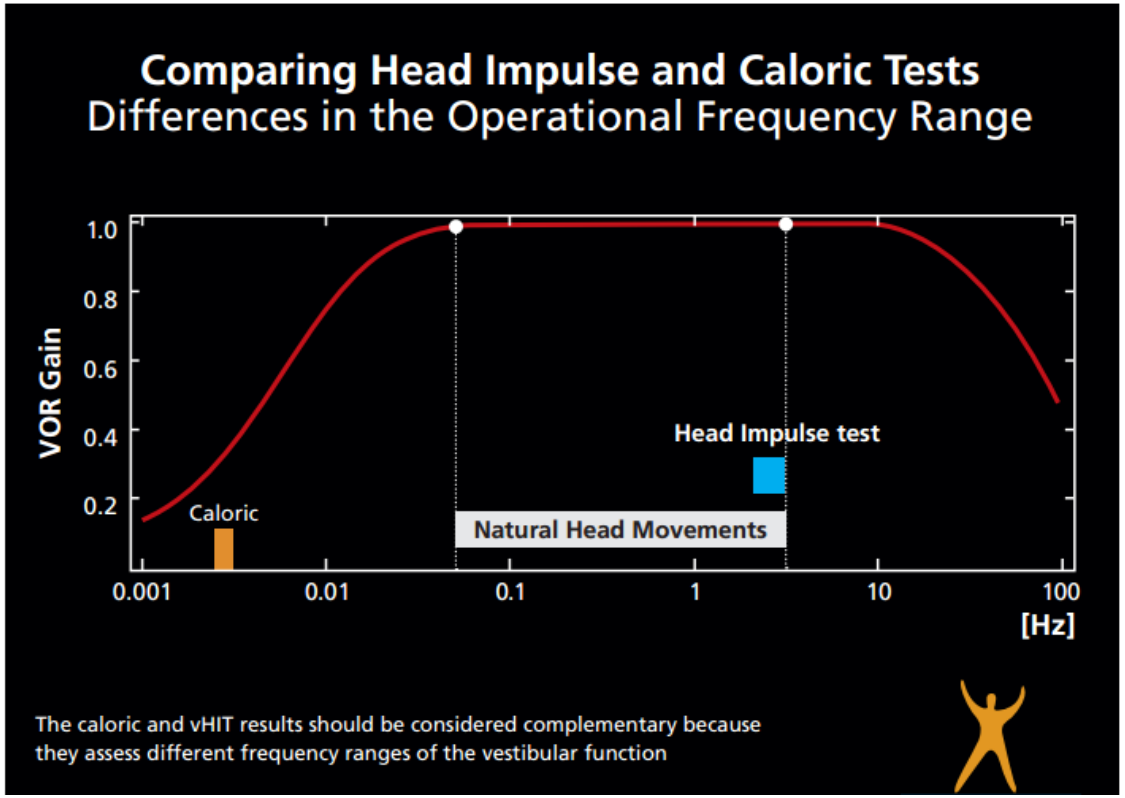
- Assess all six semi-circular canals independently
  - Total or partial loss
- Distinguish between central TIA and peripheral vestibular lesion (Newman-Toker et al, 2008)
- Serial testing to monitor vestibulo-toxicity
  - No evidence of adaptation to vHIT
- Can be modified for use in children

Does the vHIT replace the caloric?

Caloric	vHIT
Ear specific	Ear specific
Relative measure of right vs left	Absolute measure of right and left
Lateral semicircular canal	All six semicircular canals
~ 0.003 Hz	~ 4-5 Hz

Comparing the vHIT and caloric

- Relative vs Absolute measure of canal function
- Differences in operational frequency range
- Time and convenience



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vHIT and VEMPs: Complete vestibular assessment

Site	LAT HIT	VERT HIT	cVEMP	oVEMP
Normal	Normal	Normal	Normal	Normal
Lateral canal	Abnormal for ipsilesional thrust	Normal	Normal	Normal
Anterior canal	Normal	Abnormal to contralesional downward thrust	Normal	Normal
Poterior canal	Normal	Abrnormal to contralesional upwards thrust	Normal	Normal
Utricle	Normal	Normal	Normal	Abnormal for contralesional eye muscle
Saccule	Normal	Normal	Abnormal for ipsilesional SCM	Normal
Superior VIII	Abnormal for ipsilesional thrust	Abnormal for contralesional downwards thrust	Normal	Abnormal for contralesional eye muscle
Inferior VIII	Normal	Abnormal for ipsilesional downards thrust	Abnormal for ipsilesional SCM	Normal
Total unilateral loss	Abnormal for ipsilesional Thrust	Abnormal for contralesional downwards and ipsilesional upwards thrusts	Abnormal for ipsilesional SCM	Abnormal for contralesional eye muscle

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Use of head impulse testing in vestibular rehabilitation

- Duration of the vestibular deficit and the patient's compensation can both affect vHIT results
- Saccades represent compensatory strategy brain uses to keep eyes stable during head rotation (Schubert et al. 2008)
- Covert and overt saccades are markers of gaze stability
  - Latency of compensatory saccade reduces
- Serial video HIT testing showed that the VOR gain can improve over time (Palla and Straumann, 2004)

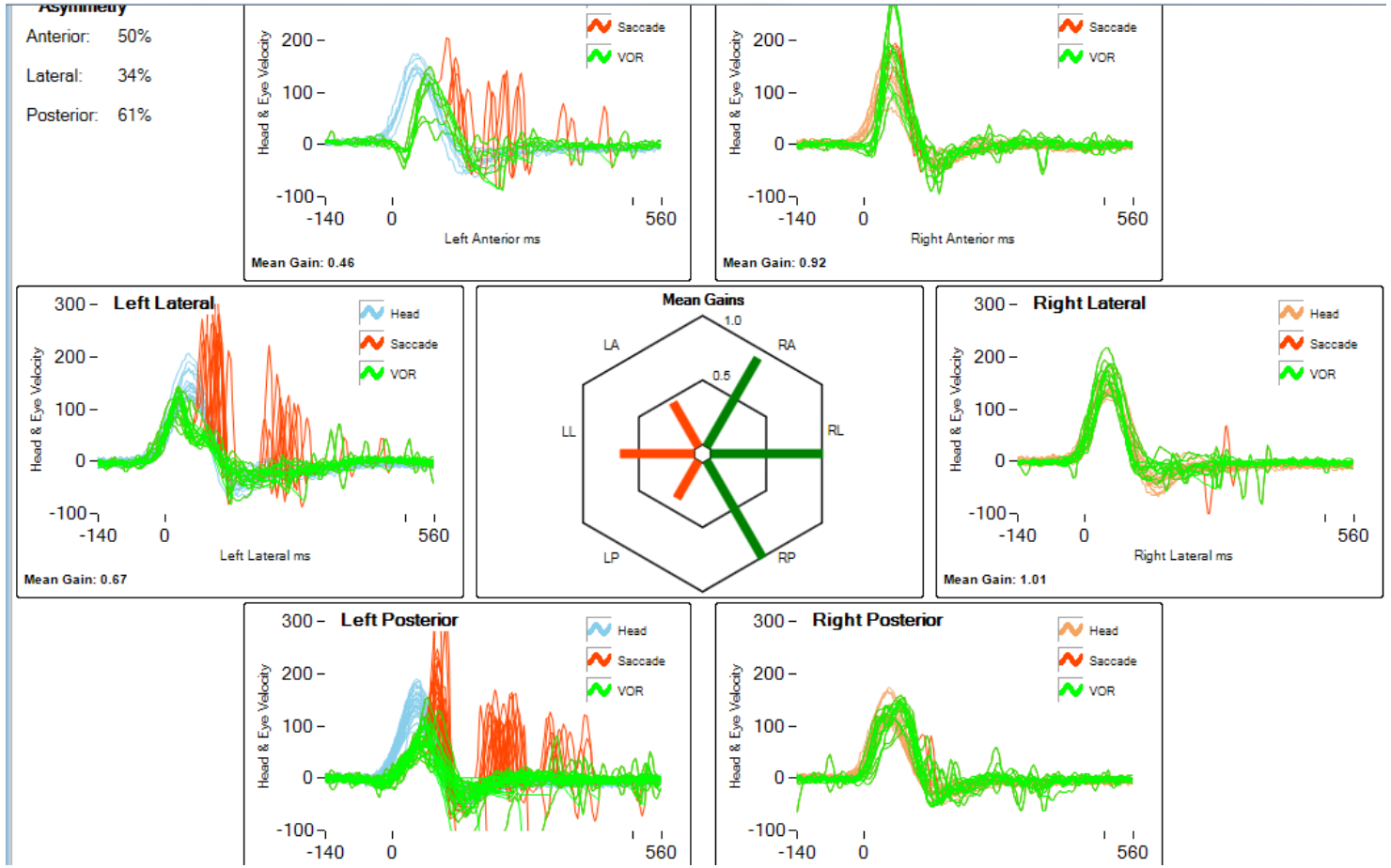
Case studies

- Summarise the results
- What do you think is a possible diagnosis in this case?
- What further testing might we want to consider for this patient?

Case study 1

Symptoms:

- Sudden onset of dizziness
- Accompanied by nausea and vomiting
- Ongoing motion sensitivity and feels disorientated when making quick movements.



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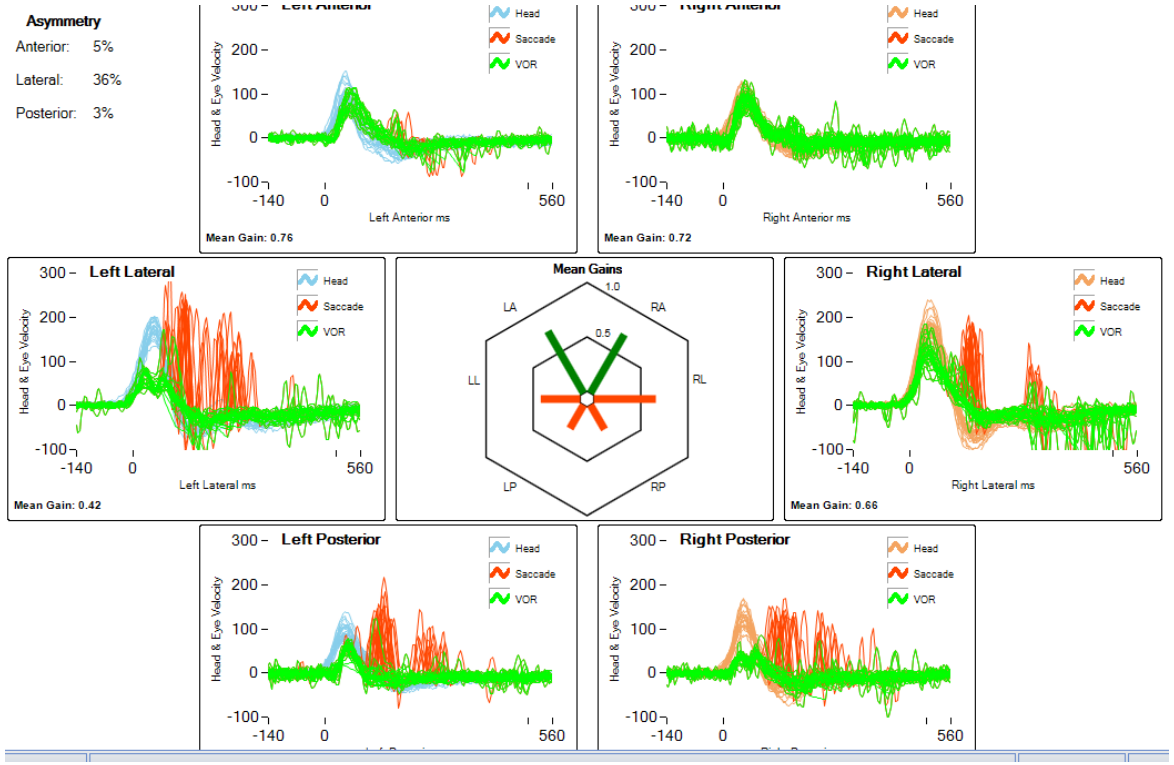
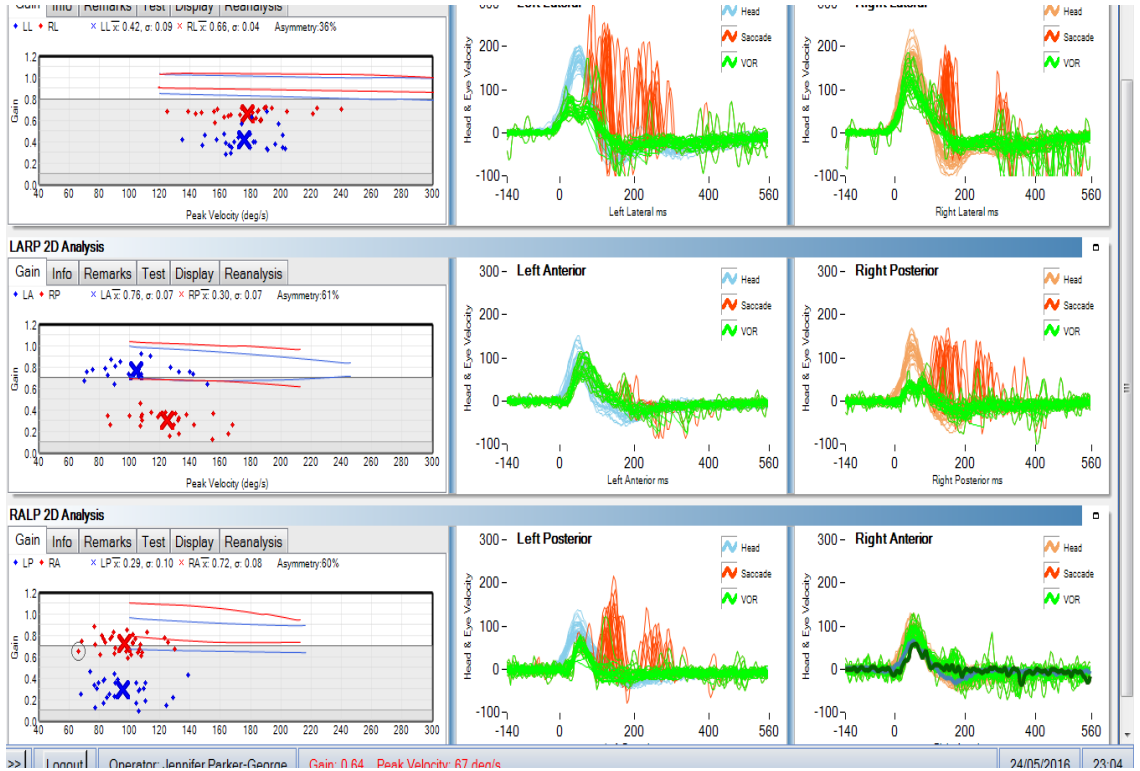
Case study 2





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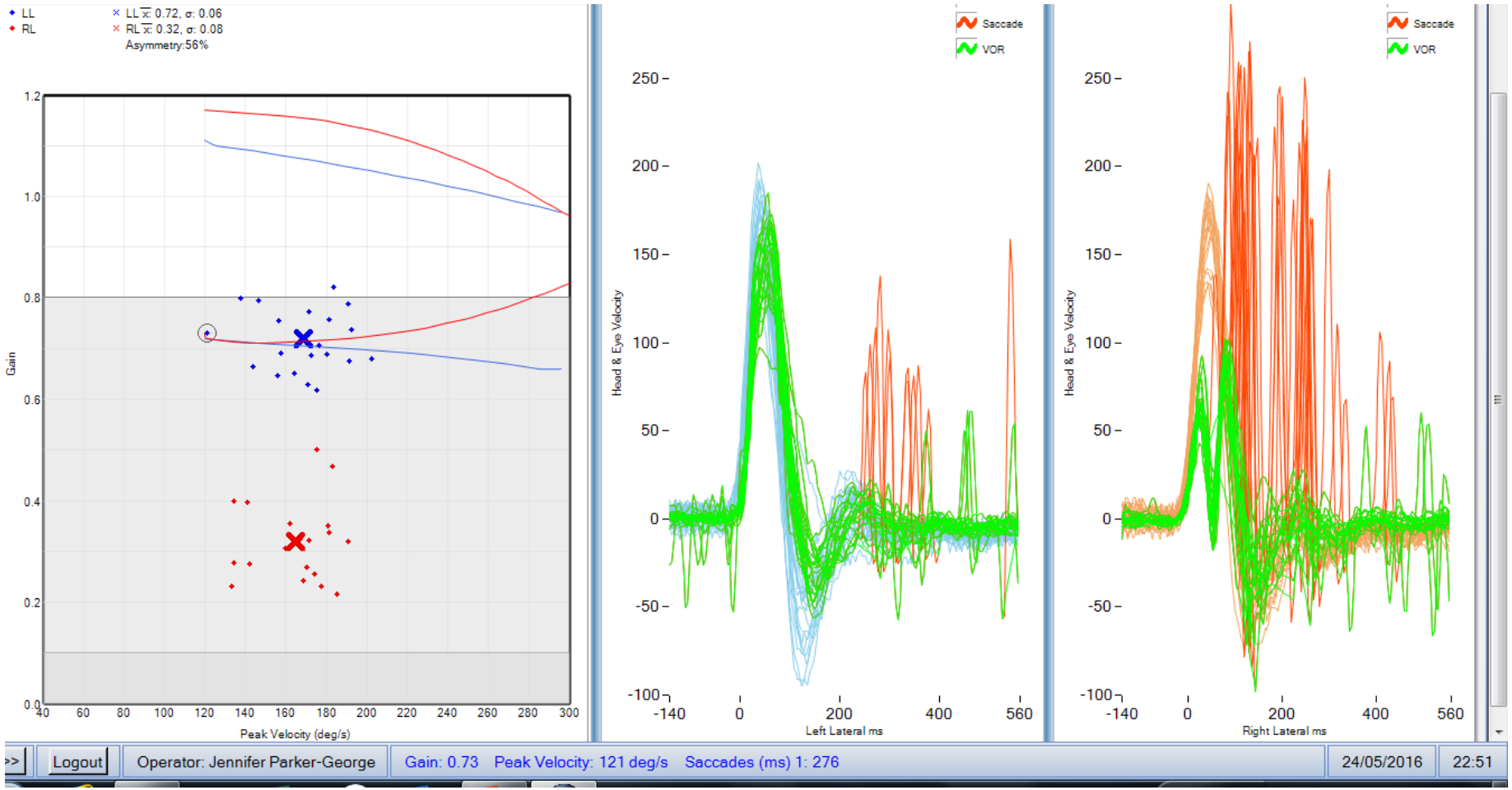
Case study 3



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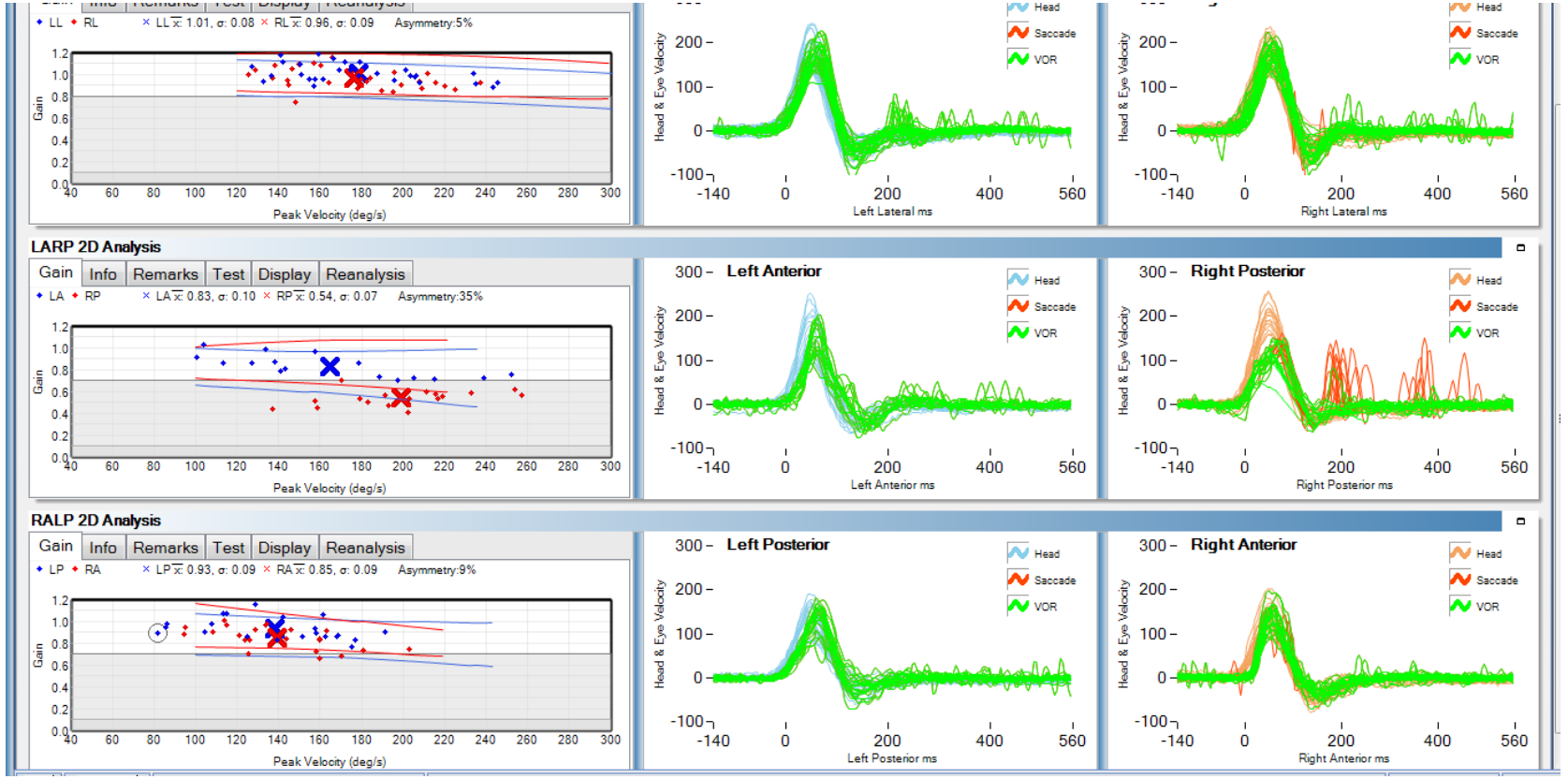
Case study 4

- Caloric results indicated no significant CP or DP


LL RL LL x̄: 1.01, σ: 0.08 RL x̄: 0.96, σ: 0.09 Asymmetry:5%
Gain
Peak Velocity (deg/s)
Head & Eye Velocity
Left Lateral ms
Right Lateral ms
Head
Saccade
VOR
LARP 2D Analysis
Gain Info Remarks Test Display Reanalysis
LA RP LA x̄: 0.83, σ: 0.10 RP x̄: 0.54, σ: 0.07 Asymmetry:35%
Left Anterior
Right Posterior
Left Anterior ms
Right Posterior ms
RALP 2D Analysis
Gain Info Remarks Test Display Reanalysis
LP RA LP x̄: 0.93, σ: 0.09 RA x̄: 0.85, σ: 0.09 Asymmetry:9%
Left Posterior
Right Anterior
Left Posterior ms
Right Anterior ms

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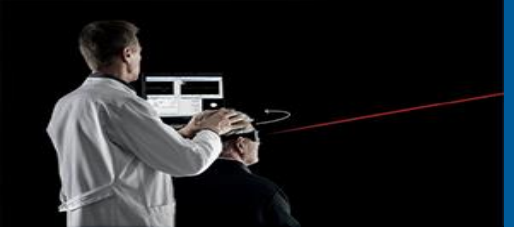

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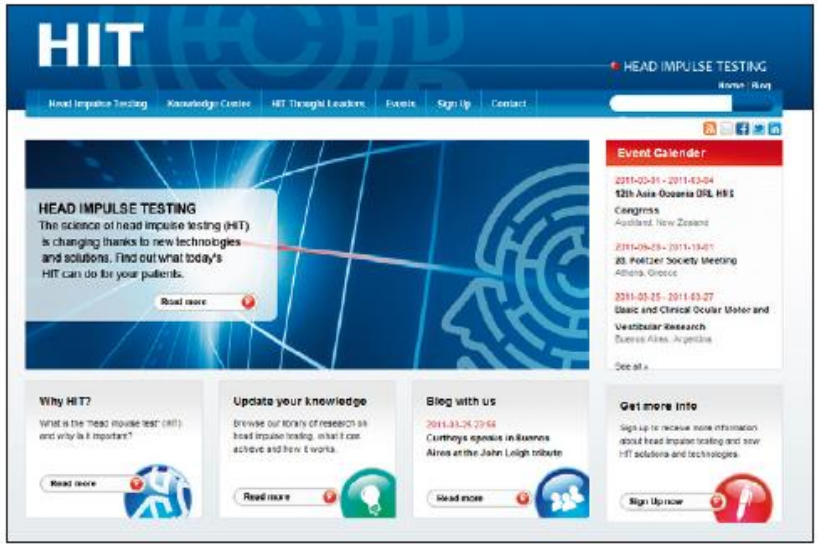
HIT
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Any questions?

jparker-George@gnotometrics.com

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